Vol. XXI. Part 6.

[Registered at the General Post Office, Melbourne, for transmission by Post as a Newspaper.]

The Journal of the Department of Agriculture of Victoria, Australia.

June, 1923.

PRINCIPAL CONTENTS

The Water Requirements of Farm Crops

Passion Fruit Culture

Rupanyup Crop and Fallow Competition

Fruit Storage Experiments

Weeds and their Eradication

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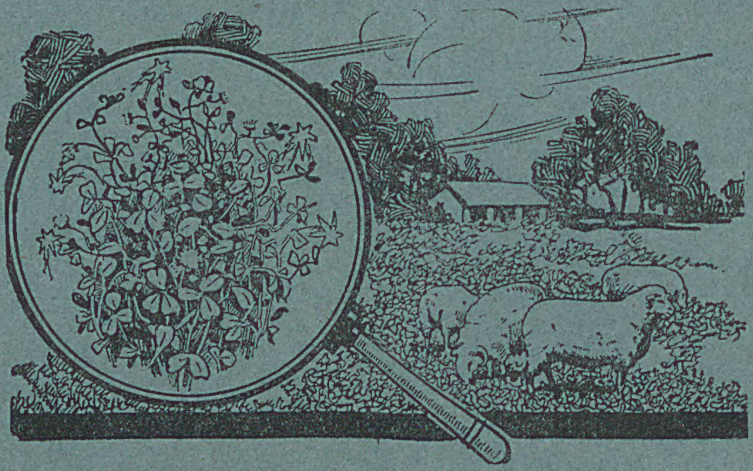

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THE JOURNAL

OF

THE DEPARTMENT OF AGRICULTURE,

VICTORIA, AUSTRALIA.

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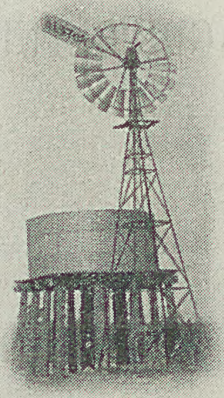

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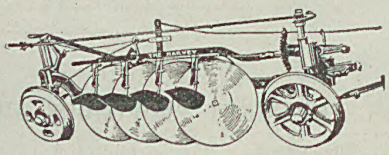

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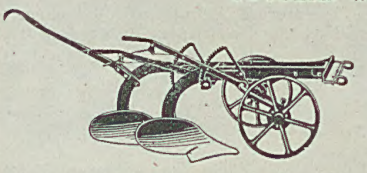

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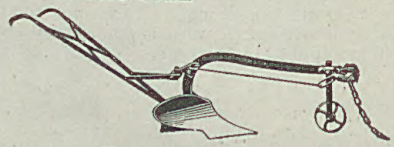

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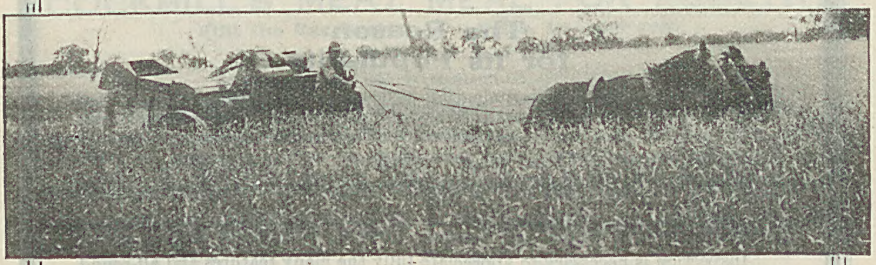

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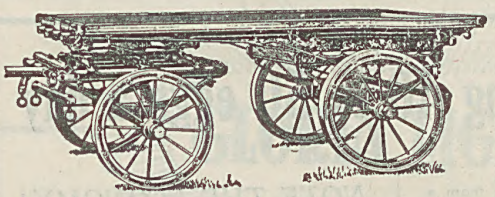

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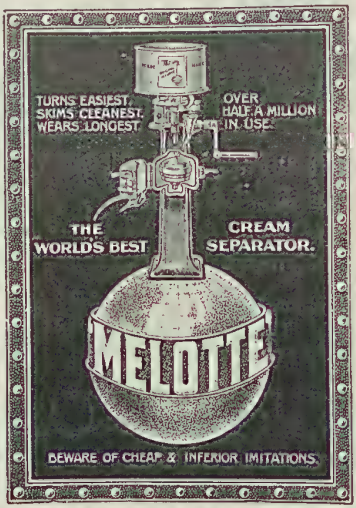

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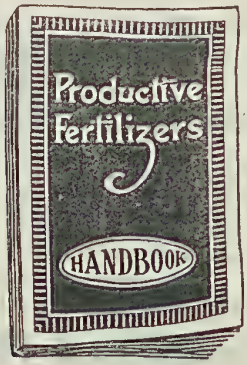

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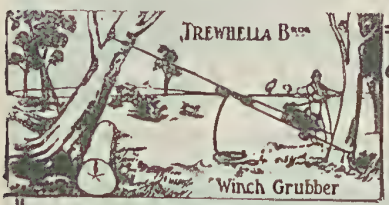

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Vol. XXI. June, 1923. Part 6.

WATER REQUIREMENTS OF FARM CROPS.

A. E. V. Richardson, M.A., B.Sc., Agricultural Superintendent.

(Continued from page 284.)

RELATIONSHIP BETWEEN TRANSPIRATION AND ABSORPTION OF MINERAL NUTRIENTS.

The Soil Solution.

In soils maintained throughout the period of growth at from 50 to 60 per cent. of saturation, the soil water would be in slow but continual capillary movement over the soil particles in the form of films. As it is long in contact with the successive particles of soil, the soil water tends to form a saturated solution with respect to the mineral mass. This soil water is the nutrient medium for plant growth, and Cameron (1910) regards it as the culture solution for the plant.

Very little is known of the soil solution because of the great difficulty in getting it away from the soil. An aqueous extract of a soil has no definite or casual relation to the soil solution in the field. The concentration of a liquid solution in contact with a complex of absorbent and absorbed material is dependent on the relative masses of solution and solid. Thus the concentration of a solution with respect to phosphoric acid when brought into contact with basic phosphates of lime or iron is dependent in a marked way upon the proportion of solution to solid.

Hence an aqueous extract of a soil will vary in concentration with the proportion of water used, and with the same proportion of water different soils will yield different concentrations.

It is well known that potassium and phosphoric acid are absorbed to a very high degree by soils from dilute solutions.

Thus Voelcker (1864) filtered barnyard liquid through loams of various kinds, and found that most of the phosphoric acid in the

liquid was speedily fixed by a moderate quantity of soil, though traces of phosphoric acid always remained in solution. He also showed that dilute solutions of potash salts were speedily fixed by small quantities of soil.

When potassium sulphate was added to a soil the potassium was precipitated, and an equivalent amount of calcium went into solution. Potassium phosphate undergoes a more complete precipitation.

Warington (1900) found that on adding ferric hydrate and aluminium hydrate to solutions of phosphate in carbonated water, 97 per cent. of the phosphoric acid had been abstracted from the solutions and deposited as phosphate of iron and alumina, while the whole of the lime remained dissolved.

Dyer (1901) was able to show by analyses of the soil from the unmanured and manured field plots at Rothamsted that the heavy dressings of superphosphate added to the manured plots since 1840 did not penetrate to the subsoil.

The ions NH_4, PO_4, and K are readily absorbed by the soil, whilst NO_3, SO_4, Cl, Mg, and Na are not precipitated. These latter are therefore the chief constituents of drainage water.

In view of the ready fixation of potash and phosphoric acid by the soil, it is to be expected that variations in the concentration of the natural soil solution in these ingredients would be less than in aqueous extracts when there is employed a constant and relatively large proportion of water to soil. Many attempts have been made to extract the solution naturally present in the soil and to analyze it. No pressure methods have been successful, but a centrifugal method has been adopted by Whitney and Cameron (1903).

By the use of powerful centrifugues with saturated soil Cameron and Whitney separated the excess of solution over and above the critical water content of the soil and analyzed it.

According to their views, soil particles are supposed to arise by disintegration, and to consist of the original minerals from which the rock was composed. Colloidal properties and clay properties begin to appear when the disintegration of the particles has gone so far as to become very minute. As most agricultural soils arise from the same minerals, they are therefore of similar chemical constitution, and the solution in contact with the particles, *i.e.*, the soil moisture, is of similar composition and concentration for all soils. They found that the amounts of phosphoric acid and potash in the soil solution were relatively constant for all soils, being 6-8 parts per million parts of solution for phosphoric acid and 20 to 30 parts per million of potash. The composition of the solution as regards nitrogen and lime, however, varied considerably with the different soils.

They further suppose that the concentration of any particular ion in the soil is not altered by the addition of soluble salts, any such addition only forcing out of solution a number of the ions already there. The soil solution is, in their view, the source of all fertility, and the function of the mineral particles is merely to hold up and distribute this solution. They further argue that this solution is unalterable in composition, and soluble fertilizers such as potassium salts do not increase the amount of food available for the plant, but owe their beneficial effects to indirect action such as the precipitation of toxic substances.

The mineral particles may certainly be regarded as the skeleton of the soil, but as Van Bemellen (1900) has pointed out, it is the colloids which impart to it many of its essential attributes.

Van Bemellen has shown that there is a close parallelism between the various interchanges and absorptions shown by the soil and those shown by colloids, and the only hypothesis capable of explaining the observed facts is that some of the constituents of the soil, and especially the clay, are colloidal. Both clay and humus can withdraw various ions, NH_4, K, and PO_4, from their solutions.

Russell (1912) regards the mineral particles, especially the fine silicate particles, as coated with a colloidal complex containing silica, alumina, ferric oxides, alkaline bases and phosphoric acid derived from the weathering of rock material and the humus, and that these various components are not in true chemical combination, but in a state of solid solution. The complex is decomposable by changes of temperature, concentration, and soil solution, but it decomposes continuously.

Whitney and Cameron assume the colloidal substances to be particles of any composition, provided only that they are small enough.

Van Bemellen regards the colloidal substances as decomposition products of weathered silicates. Whitney and Cameron assume that the soil solution is in equilibrium with definite silicates and constant in concentration, whilst Van Bemellen assumes it to be in equilibrium with a colloidal complex, and to depend for its concentration on the masses of constituents present in the complex.

The part which the total concentration of the solution takes in plant nutrition is not clear. Cameron contends that plants growing in water cultures are not influenced to any extent by wide variations in the total concentration of the solution. Tottingham (1914) concluded that nutrient solutions ranging from .01 to .14 per cent. do not affect the dry weight of wheat plants grown in these solutions.

Stiles (1915) considered that the individual variations of plants grown in water cultures is as large as or larger than that which is often accredited to a variation in the composition of the solution.

On the other hand, the results of researches of Hall, Brenchley, and Underwood (1914) were decidedly in contrast to the evidence cited above.

These investigators grew barley and wheat in solutions made by extracting the soils from certain Rothamsted plots on which wheat and barley had been grown for over 60 years. The comparative growth in the solutions was closely parallel to the growth of the crop on the plots in the field, and corresponded to the composition of the solutions. Moreover, growth in soil solutions agreed with the growth in artificial culture solutions containing equivalent amounts of phosphoric acid and potash. In nutritive solutions of varying degrees of dilution the growth of plants varied directly, but not proportionately, with the concentration of the solution, though the total plant food present in the solution was in excess of the requirements of the plant.

They concluded from their investigations (1) that the composition of the natural soil solution as regards phosphoric acid and potash is not constant, but varies significantly in accord with the composition of the soil and its past manurial history. (2) Within wide limits the

rate of growth of a plant varies with the concentration of the nutritive solution, irrespective of the total amount of plant food available.

The results of Shive's experiments (1915) are of considerable interest in this connexion. Wheat was grown in solutions of three different total concentrations—1, 1.75, 4.0 atmospheres in terms of total possible osmotic pressure. The solution was the three-salt solution first used by Birner and Lucanus, containing Ca $(NO_3)_2$ $MgSO_4$ and KH_2PO_4. All possible sets of proportion of these salts were included for increments of change equal to one-tenth of the total osmotic pressure. As judged from the extensive quantitative date collected, Shive concluded that the growth of wheat plants in solutions of any given salt proportion was determined by the concentration of the medium.

We may conclude from the investigations of Hall and his associates, and Shive, that the composition of the soil solution which determines the growth of the plant is not constant, but is dependent upon the amount and the mode of combination of the phosphoric acid and potash in the soil, both of which *are* affected by the fertilizer supply.

Soil Solution and the Transpiration Ratio.

When plants are grown in nutrient solutions of varying concentration the water requirement is generally greater in the lowest concentrations. This was shown by Heinrich (1894), who grew oat plants in culture solutions of different concentrations. The nutrient solution consisted of calcium nitrate, magnesium sulphate, potassium phosphate, calcium chloride, and freshly precipitated suspended iron phosphate. Ten jars each of three litres were used for each of five concentrations. With the exception of the weakest concentration, the Transpiration Ratio decreased as the concentration of the solution increased.

Bouyoucos (1912) found that the concentration of the nutrient solution has a decided influence on transpiration the higher concentrations diminishing water loss either (1) because of the difficulty experienced by the plant in absorbing water from a solution of higher osmotic pressure; (2) because the increased concentration of the cell sap decreased vapour tension, and so reduced transpiration.

Hellriegel (1883) Germany; Widstoe (1909) U.S.A.; Leather (1910-11) India; Kiesselbach (1910) U.S.A.; conducted tests to show the effect of fertilizers on the Transpiration Ratio. In all these cases there was a considerable reduction in the water requirement brought about by the use of manures.

Kiesselbach measured the water requirement of corn grown in three types of soil—infertile, intermediate, and fertile, and showed that there was marked reduction in the water requirement with increase in soil fertility, and that fertilizers had a greater effect on the reduction of the water requirement in poor soil than in fertile soil.

In highly productive soils the reduction amounts to only a small percentage, but in poor soils the water requirement may be reduced by one-half or even by two-thirds.

Hoagland (1919) grew plants in a favorable nutrient medium to a uniform stage of development, and then transferred them for short periods to solutions of varying concentration. He found that transpiration was greater from solutions of low concentrations. Absorption and

transpiration took place independently, so that the solution under some circumstances might become either more or less concentrated, depending on the original concentration of the solution.

The investigations recorded in this paper show that the effect of a heavy dressing of a complete fertilizer was to materially lower the Transpiration Ratio, not only for dry matter, but for grain also.

The lowered water requirement brought about by the use of fertilizers is often explained by the assumption that in an infertile soil the nutrient soil solution is weak, and the crop must transpire large quantities of water to secure the necessary amount of nutrient, whereas in a fertile soil a more concentrated nutrient solution surrounds the soil particles, and a relatively small quantity of water is required to bring the necessary nutrients into the plants; that the plant exercises control over this transpiration rate, and can thereby control the amount of nutrients absorbed.

It is further assumed that the amount of nutrients taken up by the plant from the soil solution is proportional to the amount of water transpired, and that the amount of transpiration varies inversely with the density of the nutrient solution.

If the transpiration rate were dependent on the concentration of the soil solution, we should expect to find that plants showing a high water requirement would be richer in mineral nutrients than those with low Transpiration Ratios.

Sorghum, millet, and maize have much lower Transpiration Ratios than wheat or oats, but the composition of the ash of these crops bears no relationship to their relative Transpiration Ratios.

Hasselbring (1914) showed that tobacco plants grown in the open transpired 28 per cent. more water than those grown in the shade. The plants which absorbed and transpired the greater quantity of water contained the smaller percentage and smaller absolute quantity of ash.

It appears from Hasselbring's experiments that the absorption of salts by the roots is independent of the absorption of water, and that the transpiration stream does not exert an accelerating effect on absorption of salts.

Further, even the same crop differs very widely in its Transpiration Ratio when grown on the same soil, but at different periods of the year. Summer-grown wheat both at Werribee and Rutherglen has a 60 per cent. higher water requirement than the same variety of winter-grown wheat, but the composition of the two crops is practically identical.

Lucerne during January and February frequently has a water requirement from two to three times greater than that grown in August and September, but the variations in ash constituents of the crop are trifling in comparison with the difference in the Transpiration Ratio.

Generally speaking, the mineral matters occur in the plant in proportions quite different from the proportions found in the soil solution. Nor does the ash of plants contain all the mineral matters which occur in the soil solution. Aluminium for example is almost entirely absent from the majority of the plants, although it is abundantly present in nearly all soils, and many of its compounds are soluble.

The nutrition of the potato plant has already been discussed. Approximately 75 per cent. of the nitrogen, phosphoric acid, and potash was taken in by a potato crop in the first 58 days of its growth, notwithstanding the fact that during this period only half the total dry matter had been built up.

The march of transpiration for the potato is similar to that of other crops, and approaches a maximum near the flowering stage. The greater part of the nutrient material is absorbed during the first half of the crop's growth, considerably before the losses of water by transpiration approach the maximum. Hence it would appear that with the potato crop the period of maximum transpirational activity occurs when the intake of mineral solutes is relatively small.

These considerations force us to the conclusion that the absorption of nutrients by the roots is independent of the transpiration stream. The reduction in the amount of water transpired per unit of dry matter with a concentrated nutrient solution is due to a more uniform and vigorous growth of the plant rather than to a reduction in the rate of transpiration.

The amount of water transpired by crops grown in fertile soil or in a soil liberally supplied with fertilizers is actually greater than that transpired by the crop on the unmanured or infertile soil. This is due to the increased development of the plant and the greater transpiring surface.

In the liberally manured soil the crop continues to increase in dry matter in an economical manner throughout the whole of the time that it is transpiring water. In the unmanured or infertile soil the crop continues to transpire water, but is retarded by malnutrition, and the water cost of the dry matter produced is therefore exceptionally high.

The high water cost of dry matter produced may be caused by a deficiency of a single nutrient, *e.g.*, deficiency of available phosphoric acid in Australian soils. As the supply of such a nutrient approaches exhaustion the rate of growth as measured by carbon assimilation is greatly reduced, but there is no corresponding change in the transpiration rate, with the result that the water requirement of the crop is abnormally high.

EFFECT OF SEASON ON THE WATER REQUIREMENTS OF CROPS.

Reference has already been made to the effect of physical factors of environment on transpiration. It now remains to consider the influence of season on the water requirements grown under constant conditions so far as soil, fertilizer, and degree of moisture saturation are concerned.

Wheat, oats, barley, rye, peas, rape, mustard, tares, and lucerne were grown in Rutherglen silt loam in pots maintained at a uniform degree of soil saturation (60 per cent. of water holding capacity) for seasons 1915, 1916, 1918, 1919. Each experiment was conducted in triplicate. No results were obtained during season 1917 owing to unavoidable curtailment of experimental work due to the war. As the lucerne crops made their main growth during the summer months the results will be considered apart from those obtained from the winter-grown crops.

The results for season 1915 have already been considered. The results for the remaining three seasons are summarized below.

TABLE XVIII.

WATER TRANSPIRED, DRY MATTER PRODUCED, AND TRANSPIRATION RATIO FOR FARM CROPS, SEASON 1916—RUTHERGLEN EXPERIMENT FARM.

Series.	Crop.	Water Transpired.	Total Dry Matter.	Weight of Seed.	Transpiration Ratio.	
					Dry Matter.	Seed.
		lbs.	grms.	grms.		
$A1_1$	Wheat (Federation) ..	86·05	96·47	34·180	404	1140
$A1_2$	,, ,, ..	68·88	96·347	35·247	322 } 366	885 } 1045
$A1_3$	,, ,, ..	86·16	105·064	35·144	372	1111
$A2_1$	Barley (Cape) ..	71·87	94·377	28·477	345	1143
$A2_2$	,, ,, ..	74·50	103·708	34·638	325 } 324	975 } 1040
$A2_3$	,, ,, ..	62·72	93·738	27·588	303	1030
$A3_1$	Oats (Algerian) ..	79·60	122·595	46·675	294	772
$A3_2$	,, ,, ..	91·72	148·333	60·543	280 } 294	686 } 744
$A3_3$	,, ,, ..	94·05	137·945	54·965	309	775
$A4_1$	Rye (Winter) ..	70·24	120·559	32·909	264	966
$A4_2$	,, ,, ..	78·62	128·356	31·886	278 } 283	1117 } 1096
$A4_3$	,, ,, ..	80·62	118·150	30·100	307	1205
$A5_2$	Rape (Essex) ..	41·14	50·635	..	369 } 384	..
$A5_3$	,, ,, ..	41·50	53·340		353	
$A6_1$	Peas (Dun) ..	43·38	60·588	31·278	325	629
$A6_2$	,, ,, ..	43·30	59·501	28·826	330 } 331	681 } 655
$A6_3$	,, ,, ..	45·60	60·985	31·650	339	654
$A7_1$	Lucerne (Hunter River)	154·29	108·17		646	
$A7_2$	,, ,, ,,	163·32	112·47	..	659 } 675	..
$A7_3$	,, ,, ,,	159·58	100·58		720	
$A8_1$	Vetches (Golden) ..	74·39	84·15	27·75	401	1216
$A8_2$	,, ,, ..	74·92	90·22	30·818	377 } 393	1103 } 1214
$A8_3$	,, ,, ..	81·45	91·85	27·985	402	1322
$A9_2$	Mustard	33·84	52·98	..	..	..
$A9_3$	,, ...	29·68	47·41	..	..	..

It is apparent that the water requirements of crops vary considerably from season to season, not only for the production of dry matter, but also for grain. It is clear that there is no such thing as a definite water requirement which is constant for any given crop. There is, as a matter of fact, a marked variation in the Transpiration Ratio in different years, due to natural climatic differences. Nor do the various crops always show the same relative water requirement for each season. For each type of crop there is at each stage of growth a combination of air temperature, water supply, humidity, which is most favorable for growth and heavy yield.

Crops which grow vigorously and receive no checks throughout growth will show a lower water requirement than crops which receive checks from over supply or shortage of soil moisture, malnutrition, disease, *e.g.*, rust, flagsmut, takeall with cereals, &c. As the seasons vary widely with respect to rainfall, air temperature, humidity, evaporation, and the incidence of fungoid diseases, it is to be expected that the water requirements will vary also.

TABLE XIX.—WATER TRANSPIRED, DRY MATTER PRODUCED, AND TRANSPIRATION RATIOS FOR FARM CROPS, SEASON 1918—RUTHERGLEN EXPERIMENT FARM.

Plot.	Crop.	Water Lost.	Evaporation from Fallows.	Water Transpired.	Dry Matter in—			Transpiration Ratio.	
					Straw.	Grain.	Total.	Dry Matter.	Grain.
		lbs.	lbs.	lbs.	grams.	grams.	grams.		
$A1_1$	Wheat (Federation)	102·25	3·09	99·16	74·02	33·03	107·05	419	1362
$A2_2$	,, ,,	111·5 } 112·25	,,	108·41 } 109·16	82·10 } 81·88	39·37 } 37·24	121·47 } 119·12	404 } 415	1250 } 1332
$A1_3$	,, ,,	123·0	,,	119·91	89·53	39·31	128·84	421	1384
$A2_1$	Barley (Cape)	157·5	3·09	154·41	120·29	79·78	200·07	350	878
$A2_2$	,, ,,	147·0 } 147·58	,,	143·91 } 144·47	113·83 } 112·26	67·35 } 69·13	181·18 } 181·39	360 } 362	970 } 955
$A2_3$	,, ,,	138·25	,,	135·16	102·67	60·25	162·92	376	1018
$A3_1$	Oats (Algerian)	123·25	3·09	120·16	93·5	49·70	143·2	381	1097
$A3_2$	,, ,,	134·00 } 126·50	,,	130·91 } 123·41	104·07 } 96·73	52·15 } 50·63	156·22 } 147·36	380 } 380	1142 } 1106
$A3_3$	,, ,,	122·25	,,	119·16	92·62	50·06	142·68	380	1080
$A4_1$	Rye (Winter)	148·00	3·09	144·91	97·18	44·10	141·28	464	1492
$A4_2$	,, ,,	79·00 } 120·67	,,	75·91 } 117·58	43·63 } 75·28	20·42 } 33·94	64·05 } 109·19	531 } 495	1687 } 1595
$A4_3$	,, ,,	135·00	,,	131·91	84·95	37·30	122·25	490	1606
$A5_1$	Rape (Dwarf Sussex)	227·12	3·09	224·03			146·11	690	
$A5_2$	,, ,,	196·5 } 208·04	. ,,	193·41 } 204·95	..	..	143·55 } 151·38	610 } 616	..
$A5_3$	,, ,,	200·5	,,	197·41			164·47	543	
$A6_1$	Peas (Dun) ..	45·68	3·09	42·59	24·81	26·88	51·69	373	719
$A6_2$	,, ..	46·25 } 46·83	,,	43·16 } 43·77	30·01 } 29·43	31·32 } 30·31	61·33 } 59·74	318 } 333	626 } 659
$A6_3$	,, ..	48·56	,,	45·57	33·47	32·47	66·21	308	631
$A8_1$	Tares (Golden)	170·0	3·09	166·91	136·31	36·1	172·41	430	2099
$A8_2$	,, ,,	176·0 } 177·16	,,	172·91 } 174·07	129·44 } 132·17	42·68 } 40·63	172·12 } 172·80	453 } 452	1839 } 1953
$A8_3$	,, ,,	185·5	,,	182·41	130·76	43·12	173·88	475	1920
$A9_1$	Mustard ..	170·75	3·09	157·66			217·68	348	
$A9_2$	,, ..	170·25 } 141·42	,,	167·16 } 138·33	..	..	194·70 } 176·66	388 } 348	..
$A9_3$	,, ..	83·25	,,	80·16			117·60	308	

TABLE XX.—WATER TRANSPIRED, DRY MATTER PRODUCED, AND TRANSPIRATION RATIO FOR FARM CROPS, SEASON 1919—RUTHERGLEN EXPERIMENT FARM.

Plot.	Crop.	Water Lost.	Evaporation from Fallows.	Water Transpired.	Dry Matter in—			Transpiration Ratio.	
					Straw.	Grain.	Total.	Dry Matter.	Grain.
A1	Wheat ..	lbs. 106·00	lbs. 3·68	lbs. 102·31	grams. 53·09	grams. 37·91	grams. 91·00	510	1225
$A2_1$	Barley ..	139·50	3·68	135·81	85·86	53·25	139·11	443	1158
$A2_2$	,, ..	144·75 } 144·99	,,	141·06 } 141·31	82·60 } 79·49	68·85 } 56·93	151·45 } 136·42	423 } 476	930 } 1153
$A2_3$	,, ..	150·93	,,	147·00	70·00	48·70	118·70	562	1370
$A3_1$	Oats ..	117·877	3·68	114·19	64·34	28·45	92·79	559	1822
$A3_2$	,, ..	99·25 } 107·36	,,	95·57 } 103·68	50·01 } 59·09	24·41 } 26·49	74·41 } 85·57	583 } 552	1777 } 1776
$A3_3$	,, ..	105·00	,,	101·32	62·91	26·60	89·51	514	1729
$A4_1$	Rye ..	154·12	3·68	150·44	83·01	33·35	116·36	587	2048
$A4_2$	,, ..	166·25 } 159·71	,,	162·57 } 156·03	102·02 } 88·74	27·69 } 32·47	129·71 } 121·21	569 } 585	2665 } 2216
$A4_3$	,, ..	158·75	,,	155·07	81·20	36·37	117·57	599	1936
$A5_1$	Rape ..	192·12	3·68	188·44			136·57	626	
$A5_2$	,, ..	161·37 } 177·43	,,	157·69 } 173·75	..	..	112·48 } 126·75	636 } 623	..
$A5_3$	,, ..	178·87	,,	175·69			131·20	608	
$A6_1$	Pease ..	59·50	3·68	55·82	29·90	34·75	64·65	392	729
$A6_2$	,, ..	68·50 } 62·83	,,	64·82 } 55·82	34·19 } 29·75	36·68 } 33·46	70·87 } 63·22	415 } 428	802 } 807
$A6_3$	,, ..	60·50	,,	56·82	25·17	28·97	54·14	476	890
$A8_1$	Tares ..	83·37	3·68	79·69	34·17	14·05	48·22	750	2575
$A8_2$	,, ..	111·50 } 100·04	,,	107·82 } 96·36	38·02 } 37·06	18·55 } 17·04	56·57 } 54·10	865 } 806	2639 } 2568
$A8_3$	,, ..	105·25	,,	101·57	39·00	18·52	57·52	802	2490
$A9_1$	Mustard ..	115·25	3·68	111·57			88·26	574	
$A9_2$	,, ..	132·75 } 125·25	,,	109·07 } 121·56	..	..	94·28 } 94·37	525 } 553	..
$A9_3$	,, ..	127·75	,,	124·07			100·56	560	

The water requirements of each crop for a period of four years and the average water requirements for the duration of the test are summarized in Table XXI.

TABLE XXI.

AVERAGE DRY MATTER PRODUCED AND TRANSPIRATION RATIOS FOR DRY MATTER AND GRAIN FOR FOUR SEASONS—1915, 1916, 1918, 1919—RUTHERGLEN EXPERIMENT FARM.

Crop.	1915.			1916.			1918.			1919.			Average for Four Years.	
	Dry Matter.	Transpiration Ratio for—		Dry Matter.	Transpiration Ratio for—		Dry Matter.	Transpiration Ratio for—		Dry Matter.	Transpiration Ratio for—		Transpiration Ratio for—	
		Dry Matter.	Grain.		Dry Matter.	Grain.		Dry Matter.	Grain.		Dry Matter.	Grain.	Dry Matter.	Grain.
	grams.			grams..			grams.			grams.				
Wheat ..	111·9	231	755	99·2	366	1,045	119·1	415	1,332	91·0	510	1,225	380	1,088
Barley ..	135·1	237	558	97·3	324	1,040	181·4	362	955	136·4	476	1,153	350	926
Oats	125·3	332	1,136	136·3	294	744	147·3	380	1,106	85·5	552	1,776	390	1,190
Rye	114·8	320	1,191	122·4	283	1,096	109·2	495	1,595	121·2	585	2,216	421	1,525
Peas	141·0	283	571	60·3	331	655	59·7	333	659	63·2	428	807	344	673
Rape	166·4	339	..	52·0	384	..	151·4	616	..	126·7	623	..	490	..
Mustard ..	84·3	464	..	50·2	287	..	176·6	348	..	94·4	553	..	414	..
Tares	50·46	721	..	88·7	393	..	172·8	452	..	54·1	806	..	593	..
Average Transpiration Ratio each Season ..		365	842	..	333	916	..	425	1,129	..	567	1,435	422	1,080

TABLE XXII.

SHOWING AVERAGE WATER REQUIREMENTS OF CROPS FOR FOUR SEASONS AND INTENSITY OF PHYSICAL FACTORS DURING PERIOD OF MAXIMUM TRANSPIRATION—RUTHERGLEN EXPERIMENT FARM.

	1915.	1916.	1918.	1919.	Average for two Seasons, 1915–1916.	Average for two Dry Seasons, 1918–1919.
Average water requirement for eight crops tested (wheat, barley, oats, rye, peas, rape, mustard and tares) ..	366	333	425	567	350	496
PHYSICAL FACTORS.						
1. Evaporation from free water surface—						
(*a*) June to December (inches)	20·8	19·01	24·74	28·35	19·55	26·55
(*b*) October (inches) ..	3·54	3·37	3·73	4·93	3·45	4·33
(*c*) October to November (inches)	9·76	7·31	10·37	12·01	8·53	11·19
(*d*) October to December (inches)	13·79	13·46	18·79	21·78	13·62	19·33
2. Maximum Air Temperature (degrees F.)—						
Average for October–November	70·1	67·5	72·3	79·8	68·8	76·1
3. Mean Depression of Wet Bulb (degrees F.)—						
Average for October–November	4·95	4·5	5·45	7·15	4·72	6·30
4. Average Relative Humidity—						
October–November (per cent.)	68	72	65·5	59·5	70	62·5
5. Rainfall (inches)—						
(*a*) June to November (growing period) ..	13·86	23·42	9·51	6·05	18·64	7·78
(*b*) October to November ..	2·99	7·06	0·70	1·27	5·02	·94

Season 1915 gave on the whole the lowest Transpiration Ratio for grain, whilst 1916 gave the lowest average requirements for dry matter. For the four years during which the investigations were conducted season 1915 gave the lowest water requirement for wheat, barley, peas, and rape, whilst season 1916 showed the lowest water requirement for oats, rye, mustard, and vetches.

The Transpiration Ratios for all crops tested, both for dry matter and grain, were considerably higher during 1919 than during any other season. The water requirements for season 1918 were intermediate between the extremely high ratios of 1919 and the rather low ratios of 1915 and 1916.

Reviewing the seasons as a whole, it may be remarked that 1915 was a typical example of a good season for cereal crops. The rainfall was fairly uniformly distributed throughout the winter and spring months, while the ripening period (November-December) was characterized by uniformly dry, warm weather. There was a steady increase in air temperatures from mid-winter till harvest.

1916 was the wettest season on record, the average rainfall for the six months, June to November inclusive, being approximately 4 inches per month. During 1915, 1918, and 1919 the crops ripened during the first week of December. The 1916 ripening was delayed until the fourth week in December.

The period of maximum transpiration for the three years 1915, 1918, and 1919 occurred in October, but during the 1916 season the period of maximum transpiration was nearly a month later.

The seasonal conditions during 1918 were typical of a fairly dry season—moderate winter rainfall, light spring and summer rainfall. There was a marked increase in temperature during November, accompanied by increased depression of the wet bulb thermometer and increased evaporation.

The conditions prevailing in 1919 were those typical of a drought. The rainfall for the six months of the growing period—June to November, inclusive—was only 6.05 inches. There was a marked rise in temperature during October and November, accompanied by a marked wet bulb depression and greatly increased evaporation from a free water surface.

All the environmental factors tending to increased transpiration—air temperature, soil temperature, dryness of the atmosphere, evaporation, and number of hours of bright sunlight—were at a maximum during the period of greatest transpiration in season 1919 as compared with the three other years of the test.

The Transpiration Ratios for all crops tested during this season were higher than those of any other year. Thus the average water requirement for dry matter was 33 per cent. higher during the drought of 1919 than the dry season of 1918, and 62 per cent. higher than the mean water requirement for the two seasons 1915 and 1916.

There was a corresponding increase in the Transpiration Ratio for grain. The average water requirement for grain was 27 per cent. higher in 1919 than in 1918, and 62 per cent. higher than the average ratio for 1915 and 1916. The evaporation during October transpiration was 32 per cent. higher than in October, 1918, and 45 per cent. higher than the average evaporation for October, 1915 and 1916.

The results for the four years may be grouped into seasons of low, intermediate, and high water requirements. Seasons 1915 and 1916 gave low Transpiration Ratios, season 1918 intermediate water requirements, and 1919 was a year of high water requirements.

The water requirements show a fairly close agreement with the intensity of the physical factors. Thus 1915 and 1916 were years of high rainfall, and low evaporation from a free water surface. During the period of maximum transpiration the mean wet bulb depression and evaporation were relatively small, and air and soil temperatures were relatively low.

During 1919 the rainfall was light, evaporation intense. The period of maximum transpiration synchronized with relatively high air and soil temperatures, low humidity, and high evaporation.

Season 1918 was intermediate in regard to intensity of physical environmental factors—rainfall, evaporation, humidity, air temperature—between the droughty year 1919 and the seasons 1915 and 1916.

It is evident that the water requirement varies greatly in different seasons, due to natural climatic variations.

TABLE XXIII.

COMPARATIVE RAINFALL, EVAPORATION, MAXIMUM AIR TEMPERATURE, AND WET BULB DEPRESSION AND RELATIVE HUMIDITY FOR FOUR YEARS—1915, 1916, 1918, 1919, FOR GROWING PERIOD—RUTHERGLEN EXPERIMENT FARM.

	Rainfall.				Evaporation.				Maximum Air Temperature.				Wet Bulb Depression.				Relative Humidity.			
	1915.	1916.	1918.	1919.	1915.	1916.	1918.	1919.	1915.	1916.	1918.	1919.	1915.	1916.	1918.	1919.	1915.	1916.	1918.	1919.
	In.	In.	In.	In.	In.	In.	In.	In.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	° F.	%	%	%	%
June	3·61	3·98	2·47	1·55	1·17	1·14	0·97	1·05	53·8	52·7	55·8	56·4	1·4	1·0	0·7	1·0	88·0	92·0	95·0	92·0
July	1·98	4·39	1·24	0·75	1·96	1·05	0·99	1·16	55·1	53·6	52·2	55·5	0·9	1·5	0·6	2·4	93·0	87·0	92·0	76·0
August	2·91	3·65	3·79	1·30	1·58	1·21	1·34	1·55	55·7	54·6	58·2	58·8	1·4	1·1	1·0	1·6	88·0	91·0	91·0	86·0
September ..	2·37	4·34	1·31	1·18	2·67	2·15	2·64	2·83	61·3	64·9	64·7	65·7	2·1	3·2	3·0	2·5	85·0	77·0	77·0	82·0
October ..	2·81	3·64	0·58	0·68	3·54	3·37	3·73	4·93	65·6	65·8	64·5	75·2	4·6	4·5	4·3	5·4	69·0	72·0	72·0	66·0
November ..	0·18	3·42	0·12	0·59	6·21	3·94	6·64	7·07	74·6	69·2	80·2	84·3	5·3	4·5	6·6	8·9	67·0	72·0	59·0	53·0
Average ..	2·31	3·9	1·59	1·01	2·85	2·14	2·72	3·10	61·0	60·1	62·6	66·0	2·5	2·6	2·7	3·6	81·7	81·8	81·0	75·8
October–November	1·50	3·53	0·35	0·64	4·88	3·66	5·19	6·0	70·1	67·5	72·3	79·7	4·95	4·5	5·45	7·15	68·0	72·0	65·5	59·5

In a season of low annual rainfall, with hot, dry, windy weather at the critical period of maximum transpiration, a given crop will show a higher water requirement than in a season of normal or liberal rainfall, with cool, humid conditions during the period of rapid transpiration. In many parts of the wheat belt the evaporation rate is subject to great temporary acceleration from strong, hot, dry, north winds in October and November. A few hours of hot northerly winds, coming as they are apt to do in dry seasons and periods of drought, may greatly accelerate the rate of transpiration and cause permanent injury and a lowering of yield to the grain crop.

Fig. 21.—Map of Australia showing average annual temperature.
The dotted line in Western Australia includes the area with no stations. (After H. A. Hunt.)

Under these circumstances the Transpiration Ratio, both for grain and dry matter, will be much higher than in a normal season, or in seasons when dry spells occur, but unaccompanied by scorching northerly winds.

The evaporation from a free water surface is affected by atmospheric conditions in much the same way as the transpiration from the plant. The evaporation from a free water surface during the growing season, and particularly during the period of greatest transpiration, is an index to the amount of water transpired by a crop in any given locality.

Regions of low annual rainfall are usually regions of high evaporation. In such localities the Transpiration Ratios must necessarily be high, so that crops are likely to suffer the double disadvantage of shortage of rainfall and a high transpiration rate.

A knowledge of the rate of evaporation from a free water surface is thus as important as a knowledge of the rainfall and its incidence in determining the suitability of arid lands for settlement.

The water requirement of crops varies greatly with the climate. A low annual rainfall associated with a low evaporation rate may be of more value for crop production than a much higher annual rainfall in a region of high evaporation.

Fig. 22.—Map of Australia showing relative humidity for the month of October. (After H. A. Hunt.)

Evaporation from a free water surface is dependent on (1) temperature, (2) dryness of the atmosphere, (3) wind velocity.

The isotherms for Australia are shown in Fig. 21. The Wyndham region (Western Australia) has the highest average annual temperature, over 85 deg. F., whilst the average temperature progressively falls as we pass from the north-west coast of Australia to Tasmania, which lies within the 55 deg. isotherm. If evaporation were dependent only on temperature we should expect a steady increase in the annual evaporation as we pass from Tasmania to the Wyndham region. The annual evaporation from a free water surface in Tasmania is below 40 inches, the evaporation at Wyndham exceeds 80 inches. At the arid central region of Australia the evaporation exceeds 120 inches

per annum. Thus at Boulia (South-West Queensland) the evaporation is 124½ inches.

The relative humidity of the atmosphere of a region has an important bearing on the evaporation. Normally the air contains only a percentage of the amount of water vapour it could retain if the maximum were available. This percentage is called the relative humidity of the atmosphere. The relative humidity is usually determined from the comparative readings of a wet and dry bulb thermometer.

The lines of equal humidity for Australia for October, the period of maximum transpiration for cereal crops, are shown in Fig. 22. They are, roughly, concentric, and more or less parallel with the coast line. The area of lowest humidity lies along the arid portion of Central Australia.

This area of lowest humidity moves north or south with the apparent movement of the sun from tropic to tropic, and during January its centre is near Oodnadatta (South Australia), and in July near Powell's Creek (Northern Territory).

In this area of low humidity or great dryness of the atmosphere the evaporation from a free water surface is greater than in any other region of Australia. Very few records are available as to the actual evaporation, but such as are available indicate an annual evaporation ranging from 100 to 120 inches. As the rainfall in this region is very light, usually less than 10 inches, and very unreliable, vegetation is extremely scanty, and consists mainly of stunted xerophytic species. The evaporation steadily increases as we pass from the southern coast to the arid interior.

The following table summarizes the evaporation from a free water surface at selected centres:—

TABLE XXIV.

SHOWING MEAN ANNUAL RAINFALL, MEAN ANNUAL EVAPORATION AND EVAPORATION FOR OCTOBER IN INCHES AT SELECTED CENTRES.

	Annual Rainfall.	Evaporation, October.	Annual Evaporation.
Hobart (Tasmania)	23.66	2.90	32.41
Sydney (New South Wales)	48.12	3.71	38.00
Melbourne (Victoria)	25.60	3.34	38.81
Werribee (Victoria)	20.50	4.06	46.19
Rutherglen (Victoria)	21.50	3.71	52.80
Adelaide (South Australia)	21.03	4.73	54.49
Perth (Western Australia)	33.10	5.27	66.13
Dubbo (New South Wales)	22.04	7.29	66.37
Broken Hill (New South Wales)	9.65	7.78	85.64
Coolgardie (Western Australia)	9.27	7.49	87.74
Alice Springs (Northern Territory)	10.99	9.55	94.84
Marble Bar (Western Australia)	14.24	11.30	115.34

Fig. 23 shows the isopleths of evaporation for Australia. They are, roughly, parallel with the coast lines, and concentric to an arid centre with its axis approximately along the tropic.

Along the southern coast line of the continent the evaporation varies from 40 to 60 inches. Along the northern coast the evaporation exceeds 80 inches, whilst the arid interior has an evaporation exceeding 100 inches.

The major rainfall regions of Australia are shown in Fig. 24.

The tropical "lows" or areas of low pressure affect the northern coast from November to April, whilst the Antarctic "lows" affect the southern coast from May to October. These give two prevalent types of rainfall in Australia—the former, called the monsoonal depressions, bring rain to tropical Australia during the summer, whilst the latter—the Antarctic depressions—bring rain to the temperate southern coast during the winter months.

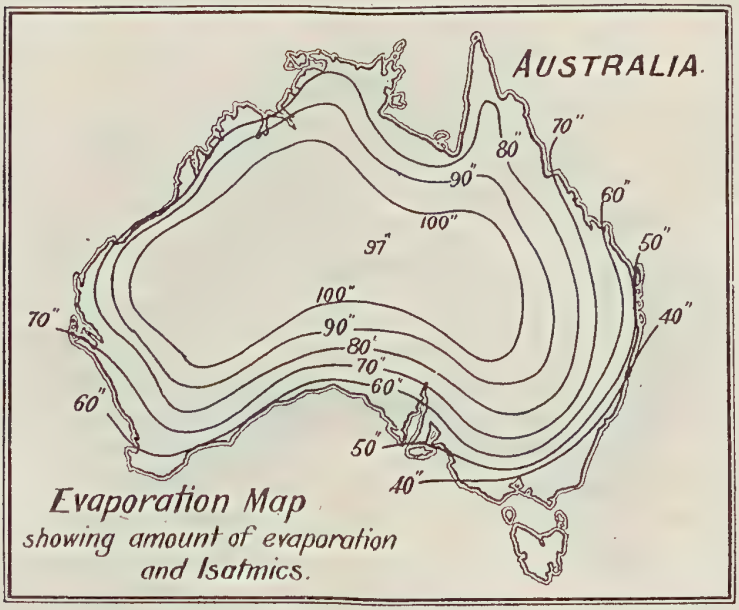


Fig. 23.—Map of Australia showing lines of equal evaporation. (After H. A. Hunt.)

The maximum fall of rain in tropical Australia is usually in January. The wet season extends from November to March. The remainder of the year is relatively dry. In the south the maximum falls usually occur in July.

In Western Australia up to 90 per cent. of the total yearly precipitation falls from April to October—the growing period of the cereal crops. In South Australia 80 to 85 per cent. of the rain falls in the growing period of the crop, whilst the proportion of winter rainfall diminishes as we approach the eastern coastline.

Between Sydney and Melbourne there is an area of overlap of monsoonal and antarctic rains, and in this region the distribution of the rainfall is fairly uniform.

Of these major rainfall regions the most reliable, and therefore the most useful for agriculture is the southern rainfall area. The most reliable rainfall occurs in the south-western portion of the continent between Perth and Cape Leeuwin. Here the rains rarely vary more than 10 per cent. from the mean.

Over the greater part of the wheat belt the average variation from the normal rainfall ranges from 15 to 20 per cent. As we pass from the wheat belt to the pastoral area the rainfall reliability rapidly decreases, and in the arid centre of the continent the average departure from the normal exceeds 50 per cent.

Fig. 24.—Map of Australia showing major rainfall regions.
The dotted line divides the summer and winter rain regions. (After Griffith Taylor.)

The rainfall reliability isopleths for Australia are shown in Fig. 25.

As we pass from the southern coast to the interior (1) rainfall diminishes, (2) rainfall reliability decreases, (3) temperature increases, (4) relative humidity of the atmosphere decreases, (5) the rate of evaporation rapidly increases.

Hence successful crop production becomes increasingly difficult because of the lessened rainfall, the greater variability of the rainfall, and the increased Transpiration Ratio.

It is now clear that it is necessary to know something more of a region than its total rainfall or even the incidence of the rain in order to determine its suitability for agricultural settlement. The reliability of the rainfall must be taken into consideration, for the average annual rainfall may be the mean of a few years of very heavy rainfall with many years in which the fall is too light for crop production.

Finally, the average annual temperature and the relative humidity of the atmosphere are very important factors, for these directly influence the rate of evaporation, which in turn has a profound effect on the water requirements of farm crops.

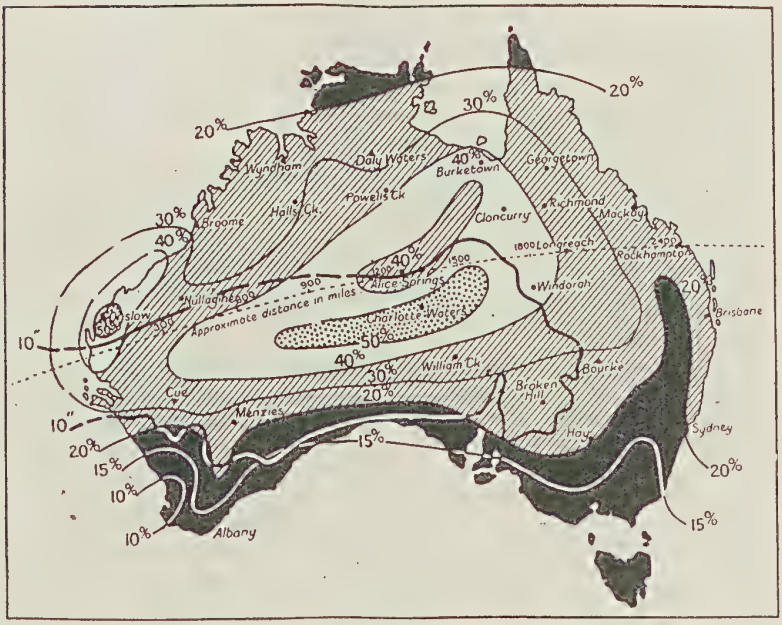


Fig. 25.—Rainfall reliability isopleths for Australia.

The figures show the percentage average deviations from the normal annual rainfall. The black areas have the most reliable and the dotted areas the least reliable rainfall. (After Griffith Taylor.)

Regions of low evaporation are regions where crop production, measured in terms of rainfall, will be efficient. Regions with a high evaporation rate—the resultant of temperature, dryness of the atmosphere, and wind velocity—will necessarily show high Transpiration Ratios for all crops grown in the region. Hence crops grown in these latter regions must necessarily be produced at a high water cost.

(To be continued.)

PASSION FRUIT CULTURE IN VICTORIA.

(Continued from page 170.)

By J. Farrell, Orchard Supervisor.

IX.—Manuring.

Good cultivation keeps the soil mellow, moist, and sweet, enabling it to yield up freely to the vines the elements of plant food and in the proportions required by them. As with fruit trees, the plant food necessary for the passions consists mainly of nitrogen, phosphoric acid, and potash; and, for passion growing, the soil should be fairly rich in these. Continuous cropping, however, gradually exhausts and disarranges the balance of these ingredients, which, if not replenished and regulated by the application of suitable organic manures or fertilizers, soon causes the vines, especially when pruning is neglected, to show signs of fundamental fatigue.

The virgin soils in the passion fruit districts contain a fair amount of plant food, and the ingredients in same are usually nicely balanced. But the growth of the vines may be considerably improved, even on these soils, by the application of manures from the time of planting. The organic manures should be worked in during late winter or early spring as the grower desires, but the quicker-acting artificial fertilizers may be applied during the currency of the main period of growth, as occasion requires.

Stable manure is considered, on the whole, probably the best for passions, and it is only a matter of using a reasonable amount of this to obtain good growth and to keep the soil in nice condition. But with the artificial fertilizers the case is different, as growers, and especially beginners, are in most instances obliged to conduct rather lengthy experiments to determine the kinds of fertilizers which suit their soils best. A chemical analysis of samples of his soil enables the grower to considerably limit the duration of his experiments, and often to omit these manurial experiments, because in purchasing artificial manures he is in a position to secure the fertilizer containing the highest percentage of plant-food elements shown by the analysis as wanting in the soil.

Organic Manures.

Notwithstanding the relatively low percentages of plant-food elements contained in stable manure as compared with those found in the artificial fertilizer, when both commodities are analyzed bulk for bulk, the former, if procurable in sufficient quantities, should be used on the passion plot. Most of the soils in the passion fruit districts being rather too loose or open, their humus burns out quickly in hot weather. The superiority of stable manure over the fertilizer consists in not alone supplying a fair amount of plant food, but, because of its organic nature when incorporated in this loose soil, it replenishes the humus supply. In this way the correct physical and chemical condition of the soil is maintained; proper drainage and good cultivation are necessary, and an occasional dressing of lime counteracts

acidity and favours beneficial soil bacteria in its activity. Under these favorable conditions the plant food is freely assimilated by the soil and made available in the proper form for absorption by the feeding roots.

Stable manure should be well rotted before being applied about October, as the chemical changes involved in its fermentation and decomposition take some time, and these changes should be as complete as possible prior to the manure's incorporation in the soil, so that the plant food may be made available as early as possible in the ensuing period of growth. It is even more essential to have manure intended for use later in the season thoroughly rotted prior to being applied, because the chemical changes necessary to provide the plant foods become relatively slower as the soil becomes drier.

Of the many points involved in determining the amount of stable manure necessary for a dressing, the following are the chief factors to be considered:—The physical nature of the soil and its condition of fertility, age, and size of the vines; amount of fruit produced the previous year and prospects of the coming season's crop. But, generally speaking, the best and most economical method of applying stable manure is to spread a layer of same, about 2 inches in thickness, over the whole of the vines' root-feeding areas during late winter, and plough in this when the soil is in a fit condition for working in early spring. Organic manures improve the physical condition of all soils, but this desirable improvement in structure is of relatively greater importance in the case of loose light loams, light sandy soils, and heavy tenacious clays than in others. These manures close up the open soils by adding humus, whereas the decayed organisms in the tenacious clays make them more friable. There is no rural industry in which a thorough knowledge of manurial benefits to the soil, and of the effects of manure on vegetation and cropping, is of greater advantage than in passion fruit culture.

Artificial Manures.

While the superiority of stable manure over the fertilizer is recognised, the distance separating the passion fruit localities from centres of population and stables attached to business establishments, where it is mostly produced, precludes its more general use. Moreover the great increase in motor traffic during recent years has had the effect of so considerably reducing the amount of stable manure available that growers, even in places fairly convenient for carriage by rail or carting, are obliged to resort largely to artificial fertilizers. Further, because of its obvious permanent future shortage, together with the ever-increasing cost of carriage and handling stable manure, growers will eventually be compelled to rely almost entirely on fertilizers with green manure to supply the humus. Planters' opinions often differ as to the best artificial manure for passion growing, but the fertilizers used in the various localities are generally selected as a result of experiments.

For the assistance of users of artificial manures, the *Fertilizers Act* 1915 requires all manufacturers and importers of fertilizers who intend offering same for sale to make application each year to the Director of Agriculture to have the respective brands of their fertilizers registered. Each application sets forth the name and place of business of the

applicant, and the figure, trade mark, or other sign attached to or associated with the fertilizer. A statement is given of the results of a chemical analysis, showing the proportion per centum of the three ingredients contained in the fertilizer, the respective forms in which these occur, and the retail price per ton of the fertilizer. The worth of each fertilizer is calculated on its unit value or the value of 1 per cent. of nitrogen, phosphoric acid, or potash in a ton of the fertilizer as shown by the results of the chemical analysis. Mr. P. Rankin Scott, Chemist for Agriculture, prepares a list of the different registered brands with full particulars for publication annually. The latest list of fertilizers registered at the office of the Director of Agriculture under the Fertilizers Act appeared in this journal for January of this year, and a supplementary list in the journal for April. These lists should be read and studied by passion fruit growers and others interested in the use of artificial manures. Fortified by the knowledge derived from a perusal of the chemist's list, the grower would be enabled, when purchasing, to secure the fertilizer containing the highest percentages of the ingredients proved by experiment or shown by soil analysis to suit his soil best.

Under the heading of "pruning" it was stated that the trellis of vines illustrated in Fig. 11 were photographed on the 12th October, 1922, after the first plant in the row was pruned, and that at the end of the growing period another illustration of the vines would be made available for comparison with this. Fig. 17 is the reproduction of another photograph of these, taken on 16th March, 1923, showing lateral and foliage development during the intervening period.

GREEN MANURE.

As well as supplying plant food, green manure improves the physical condition of most soils on which passion fruit is grown. It helps to consolidate loose loams and sandy soils by supplying humus, and when incorporated in tenacious clay the decayed organic matter separates the particles and makes the soil more friable in character. Leguminous plants, such as peas, beans, vetches, &c., aided by the nodules on their roots, are capable of fixing more of their nitrogen direct from the air, and are consequently the best for green manure. Some passion growers use cereals, oats, wheat, &c., as cover crops, but these, on account of obtaining their nitrogen from the soil, cannot be regarded as equal to the leguminous ones, which replenish the supply of soil nitrogen when the process of decomposition is completed.

The field pea (*Pisum arvense*) makes one of the best cover crops for the passion plot. The seeds may be sown broadcast or in drills after the autumn ploughing, and harrowed in with a fair dressing of artificial manure, and during fairly mild winters the peas make good growth. The time of sowing the seeds should be regulated, so that the cover crop may assume its maximum of development and be in full bloom ready to plough under during October.

The Trifolium seedling illustrated in Fig. 18 (natural size) was seventeen days old when photographed, and shows nodules on its roots. The nodules marked (*a*) and (*b*) in the illustration were cut from the roots of a plant of the same variety eight weeks old, and these are also natural size.

Fig. 17.—Trellis of Passion Vines (same as in Fig. 11, *Journal* of March, 1923, page 164) showing growth made by vines after pruning.

Heavier crops of peas are obtained when grown in drills than when the seed is sown broadcast, as the drill system permits of the soil being cultivated occasionally during late autumn and winter, when its condition is amenable to cultural treatment. The vines also benefit by this treatment of the peas, as they like the soil kept in an aerated sweet condition at all periods of the year. The peas should be ploughed in as soon as they have accumulated their maximum of cell sap, as later they become woody, in which condition they are less suitable as a green manure, and the process of decomposition is much slower. As the complete change from the green crop to that of the soluble and soil-assimilated elements of plant food rendered available for absorption by the feeding roots of the vines occupies a rather lengthy period, no time should be lost in ploughing the cover crop under when it has reached the proper stage of stem, foliage, flower, and nodule development. The peas on being ploughed under should be buried to a depth

Fig. 18.—A Trifolium seedling, seventeen days old, showing nodules on roots (natural size).

a and *b* illustrate nodules (natural size) taken from a plant of the same variety, eight weeks old.

of from 4 to 6 inches, according to the depth of the surface soil. When cultivating with harrows afterwards to conserve moisture, which is such an important factor in preparing the elements of plant food contained in the vegetable matter for assimilation by the soil, care should be taken not to bring any of the green manure to the surface until it is thoroughly decomposed. Having given his attention to the different phases of green manuring, the passion grower may reasonably assume that the chemical changes necessary to render the soluble nitrates available will have made sufficient progress to assist the vines to commence vigorous growth, and afterwards supply food for fruit production.

Lime as a Manure.

The passion vine likes a sweet soil, and most of the virgin land now being brought under its cultivation is of this nature, but many

plots develop acidity or sourness through the original lime content becoming depleted by continuous cultivation and cropping. Lime corrects acidity by uniting with the soil acids and changing them into harmless substances. It also supplies plant food and assists in liberating previously unavailable potash, thus creating a sweet healthy condition so essential to the profitable cultivation of this fruit. Lime also accelerates nitrification, the process by which the inorganic and unavailable nitrogen is rendered available by bacterial action.

Most practical passion growers are able to determine by the general appearance and results from their passion plots when the soil has developed acidity; and usually agricultural lime is employed to correct this. From 8 cwt. to 10 cwt. per acre spread over the root-feeding areas of the vines makes a nice dressing, and frequent light applications are preferable to occasional heavy ones. When it is known that soil sourness has been caused by stagnant water, lime should not be applied until the land is thoroughly drained.

A number of articles dealing with the use of lime, written by the departmental experts for this journal have been issued in bulletin form, and should be read by all passion fruit growers and others interested in the use of lime.

(To be continued.)

POULTRY AT STATE RESEARCH FARM, WERRIBEE.

NOTES FOR JUNE.

By W. Pedrick, Poultry Foreman.

June is a Month of Preparation.

Stud birds are specially housed and fed so as to get them well through the moult, and in good order for the breeding pen. For this purpose sulphur and linseed are added to the mash.

The brooder house is put in order, and thoroughly disinfected with chloride of lime to insure a good clean start for this season's chickens.

The runs adjoining the brooder and chicken houses have been scarified up, and sown down with rye grass. This will sweeten the runs, and also induce nice green picking for the young chickens.

A supply of oats, barley, and rape to be used as green stuff for the winter, has been sown on land which has been well manured during the autumn. Crops for this purpose are usually sown earlier, but, owing to the dry season, the work had to be deferred.

Shelter trees have been trimmed back to allow as much sunlight as possible on the yards during the cold, wet weather.

A keen eye must be kept on all birds, perches, &c., for traces of vermin.

The pullets are laying very well, considering the cold, bleak weather, Leghorns in the test pens laying up to 25 eggs per month, and Orpingtons to 30 per month.

"Lady Hart," the Orpington pullet which laid 313 eggs for twelve months ended 13th March, 1923, had up to the 31st May laid 368 eggs.

CROP AND FALLOW COMPETITION, RUPANYUP, 1922.

Report of Judge, H. A. Mullett, B.Ag.Sc., Senior Inspector of Agriculture.

The present competition is the fourth of its kind organized by the Society, and in submitting the report I desire to congratulate those responsible, on the success that has attended their efforts to promote the adoption of improved agricultural methods in the district. In particular, improvement is noticed in three directions, each of fundamental importance, in the growth of heavy crops of wheat.

IMPROVED SEED.

There is, for instance, a marked change for the better in the purity and type of wheat grown. Four years ago the judge of the first competition commented adversely on the type and purity of the wheat submitted to him. To-day both are deserving of nothing but praise. The change has been brought about by the enterprise of the Society in arranging to purchase pedigreed seed wheat from Longerenong College in truck lots. The wheat was allotted to individual farmers on arrival at Rupanyup, and formed the nucleus of the splendid samples now to be seen everywhere in the district. In making this statement it would be unjust not to refer to some crops grown from parcels of Federation originally purchased from private individuals, notably from Mr. Alec. Huf, of Jung. They were also exceptionally pure and true to type. During the past ten years the business in pedigreed seed wheat in the Wimmera has developed out of all knowledge. Once it was a rare thing for farmers to continue to purchase fresh seed of a variety from a seed station, now it is becoming the exception not to do so, and the demand is rapidly growing beyond the capacity of the seed stations. Unless means is found of supplementing the supply in future, some farmers may have to accept much smaller quantities than have hitherto been supplied them.

One method of meeting the increased demand would be for a few approved farmers in the Wimmera to purchase their seed from the College, multiply it and themselves grade it for sale. Up to the present little more has been done in this direction than for growers of pure seed to exchange it on their farms for an equivalent quantity deposited at the local railway station. Thus all their reward is a saving of cartage from farm to station. But first class graded seed ought to be worth at least from 1s. 6d. to 2s. a bushel above market price. And there does not appear to be any reason why specialists in the production of first class seed should not get these prices. Already the way is being pioneered. Mr. W. E. Dahlenburg, of Salisbury, who conducts the Departmental experimental plots there, and who thus derives his seed direct from the State Experimental Farms, has this year sold considerable quantities to local growers. At the annual field day held on this farm, those who attended were able incidentally to personally inspect the seed they proposed to purchase. But if the production of pure seed wheat is to pass in part into private hands adequate safeguards will have to be framed to insure that the wheat is subject to some system of improvement, that it is free from deleterious weeds and disease, and that it is true to name. There are a number of ways that will immediately suggest themselves as to how this can be done.

Better Tillage.

Another direction, equally important, in which marked improvement has been shown at Rupanyup, is in the tillage of the fallows. Summer-fallowing is rapidly increasing in popularity, and careful tillage after every rain of consequence, is the rule. The most successful competitors averaged ten to fourteen different tillage operations in preparing their fallow. One, Mr. W. Newall, of Marnoo, whose 60-acre paddock of wheat this year was considered equal to the heaviest seen in the district, had given the land upon which his crop was grown no less than eighteen

An Attractive Farm Home—Mr. R. J. Jackson's, Rupanyup.

Garden and Home of Mrs. McAllister, Marnoo.

separate workings. The ample reserves of moisture stored and the liberal supplies of plant food created in the soil by this intensive treatment can well be imagined.

Good seed and better tillage have been rightly accompanied by the general use of heavier dressings of seed and of manure. From 75 to 85 lbs. of seed per acre with from 90 to 120 lbs. of superphosphate are now the popular quantities applied at Rupanyup, and these accord closely with the quantities that have given the best results at Longerenong College on similar soils. One competitor, Mr. Newall, used as high

as 186 lbs. of superphosphate per acre on his crop, and Mr. C. Carra from 120 to 130 lbs. per acre.

The Competition, 1922.

In the three wheat sections, a total of 35 entries were inspected. In section 1, the Brunton Cup, eleven of the 23 competitors who started three years ago still remained in the field. In section 2, Best 60-acre paddock of wheat, there were nineteen competitors, and in the section for repatriated soldiers, five entries.

The Brunton Cup provided a most severe test, in that the whole of the crop grown during the past three seasons has been inspected and judged on points. Consistent success over large areas was therefore demanded of the competitors. During the currency of this competition, Rupanyup, with its extensive areas of friable black soil at Lallat and elsewhere, has enjoyed a satisfactory rainfall, though not an abnormally good one. The yield of the winner of the Brunton Cup for an average sowing of 275 acres has probably been very close to 40 bushels per acre, which speaks eloquently of his skill.

Heavy Crop of Federation Wheat, grown by Mr. R. J. Jackson, Rupanyup, winner of the Brunton Cup.

The rainfall at Rupanyup for 1922 was 17.67 inches, and that at Marnoo, 16.60 inches. The Autumn was dry; May and June were good months; July was dry, and September exceptionally good.

The distribution at Rupanyup was as follows:—

January, 30 points; February, 70; March, 2; April, 92; May, 324; June, 228; July, 82; August, 177; September, 339; October, 180; November, 18; December, 225; Total, 17.67 inches.

Frost occurred on 4th November, and caused some loss, though not over so extensive an area as at Nhill and Jung. On the whole, the yields, though good, were not as satisfactory as during the preceding year.

Results.

SECTION 1—BRUNTON CUP.

For the whole of the wheat sown 1920, 1921, 1922. *No area to be less than* 100 *acres.*

The winner of the section was Mr. R. J. Jackson, of Burrereo. He gained a total of 279 points out of a possible 300. His three crops have

been wonderfully consistent. For an area of over 275 acres, as has been stated, the average yield has been 41 bushels per acre. Not only have the yields been high, but the crops have been remarkably even and regular. There has been practically a complete absence of weeds, and the purity of the wheat was such that every bag could have been used for seed. The land, of course, is of a regular character over the whole of Mr. Jackson's farm, but that is not uncommon at Rupanyup, and on the Wimmera Plains generally. This particular soil, however, is of a somewhat lighter texture than that at Horsham, and Lallat. Mr. Jackson cultivates thoroughly, manures liberally, and uses good seed. He believes strongly in summer-fallow, and finds that it pays to till his black soil shallowly and with light implements. Often the plough is dispensed with for summer-fallowing, and reliance placed for cultivation on the scarifier, spring tooth cultivator and harrows. The heaviest paddock of wheat he grew in 1921, received 13 strokes of the various cultivating implements. Federation is the variety preferred, though a

Heavy Crop of Federation Wheat grown by Mr. John Sweetman, Rupanyup.

test has been made of Huf's Imperial with satisfactory results. This year 275 acres of wheat were inspected, half of which had been summer-fallowed and half winter-fallowed. The heaviest portion of the crop was grown partly on summer-fallow and partly on winter-fallow. The summer-fallowed portion was worked up lightly with the scarifier and disc cultivator in April. It was then harrowed twice. In September, the paddock was skim-ploughed and harrowed. In October, it was scarified and harrowed. It was left untouched save for sheep until the following April when it was harrowed. The dry Autumn did not permit of more working. In early June the paddock was scarified up, spring toothed and drilled early in July. The drill was followed by the harrows in order to cover the seed. From 90 to 95 lbs. of seed were used with 115 lbs. of superphosphate per acre.

The runner-up was Mr. W. J. Hemphill, with 264 marks. He was closely followed by Mr. C. Carra with 261, and Mr. Gordon Hemphill with 260. The Brothers Hemphill cultivate their land with great thoroughness upon a system similar to that followed by Mr. Jackson.

This year the crop was sown with a combined-drill using 90 lbs. of seed with 112 lbs. of superphosphate.

On heavier land, though not of such consistently regular quality, Mr. C. Carra has produced some heavy crops of Federation. Summer-fallow is also thought highly of, and this year important differences in favour of the crops grown after this method of preparation were noticed on his farm. As befitting the heavier soil, reliance is placed on the plough for breaking up the land, and on scarifiers to perform the bulk of the rest of the cultivation. Little harrowing is done by Mr. Carra, as he claims that his soil is inclined to "blow" if reduced to too fine a tilth. Liberal dressings of seed and manure are used. The seed on this farm was originally derived from Mr. A. Huf, of Jung, and each year was excellent. The best paddock of wheat on the property was grown after the following treatment:—Ploughed in April to three inches deep. Scarified in July and subsequently re-scarified in July, in September, and again in November. After harvest it was harrowed, then scarified again at the end of May, and sown with the combined spring-toothed drill at the end of June. The harrows followed. Ninety lbs. of seed were used per acre with 130 lbs. of superphosphate. The bulk of the wheat grown was Federation. There were also 60 acres of Huf's Imperial which looked well.

Details of Award.

SECTION 1.—BRUNTON CUP.

For whole of the wheat sown 1920, 1921, 1922.

Limited to competitors growing at least 100 acres annually.

Name.	Yield.	Type.	Weeds.	Disease.	Even-ness.	Total, 1922.	Handi-cap.	Total, 1920–21	Grand Total.
Possible Points ..	**35**	**20**	**15**	**15**	**15**	**100**	..	**200**	**300**
R. J. Jackson ..	33	19	13	14	15	94	..	185	279
W. J. Hemphill ..	29	19	11	12	15	86	..	178	264
C. Carra	35	18	12	14	14	93	..	168	261
G. Hemphill	30	19	9	14	15	87	..	173	260
A. R. Dunlop ..	26	20	7	13	13	79	..	179	258
C. W. Ellard ..	32	19	12	11	14	88	..	160	248
Carra Bros.	25	18	10	10	11	74	..	173	247
Miller Bros.	32	19	10	12	12	85	..	154	239
W. H. Kendell ..	31	17	12	11	12	83	2	154	239
C. A. Graham ..	30	16	11	13	13	83	..	147	230
R. Duncan	25	19	10	11	12	77	1	145	223
Bell Bros.	..	..	With	drawn	..	..	..	170	..
H. Holcamp	..	..	With	drawn	..	..	..	163	..
A. McKinnon	..	..	With	drawn	..	..	..	162	..
J. J. Crampton ..	..	..	With	drawn	..	..	..	160	..
Geo. Chapman ..	..	..	With	drawn	..	..	..	160	..
J. Chapman	..	..	With	drawn	..	..	..	159	..
Geo. Kennedy ..	..	..	With	drawn	..	..	..	156	..
C. Culton	..	..	With	drawn	..	..	..	152	..
D. Payne	..	..	With	drawn	..	..	..	152	..
R. Hurley	..	..	With	drawn	..	..	..	152	..
J. Sweetman	..	..	With	drawn	..	..	..	136	..
A. Schafer	..	..	With	drawn	..	..	..	125	..

Result—Section 2.

For best paddock of wheat not less than 60 acres.

In this section some very heavy crops were submitted to the judge. The first prize was awarded to Messrs. Carra Bros. for a fine paddock of Federation wheat. This was not the heaviest crop seen, but it scored well in each subdivision. The wheat was clean and of excellent type. There was a complete absence of disease. The method adopted in preparing the fallow for and in seeding this crop has already been described.

Mr. James Crampton was second with 95 points. The crop, Federation, had well-filled heads, and was level-topped and dense. The seed was derived direct from Longerenong College two years ago. The paddock of 150 acres was summer-fallowed in March to between 3 and 4 inches with the plough. In August part was re-ploughed where weeds were bad and part re-scarified. Then this was harrowed and subsequently scarified three times before harvest. In June, the paddock was re-scarified and sown at the end of the month with a combined spring-toothed drill and harrowed. Seventy lb. of seed were used with 90 lbs. of superphosphate.

A Frosted Wheat Crop, cut for hay—Messrs. Dunlop Brothers, Rupanyup. This crop yielded over three tons per acre.

Mr. W. Newall's crop of Federation at Marnoo, awarded 94 marks, was heavier than the first two. The seed was derived from Longerenong College two years ago. The wheat was well-headed and true to type. Several points were deducted for the presence of some wild oats. In view of the lighter rainfall received at Marnoo, the heavy yield secured was most commendable. It is undoubtedly due to a combination of thorough cultivation, seed of proved prolificacy and heavy dressings of fertilizer. The land was winter-fallowed in early August with a set plough to 3½ inches deep. It was then harrowed twice. In September it was scarified and twice harrowed, and similarly treated in October. In the following April, two harrowings were given. In May, a scarifying and two harrowings were given, and finally in June the paddock was scarified, harrowed, sown with a combined spring-toothed drill and harrowed. Seventy-five lbs. of seed were used with 186 lbs. of superphosphate an acre. Mr. Newall systematically follows up each scarifying with a double harrowing, the second one of which is done at right angles to the first.

Mrs. C. McAllister's crop of 120 acres was also at Marnoo. In this instance the land was summer-fallowed and no less than twelve different cultural operations were involved in preparing the fallow. The crop was sown in June with 60 lbs. of seed and 140 lbs. of superphosphate. This variety was Gallipoli. Points were deducted for the presence of a large percentage of foreign heads.

The Water Supply at Mrs. McAllister's, Marnoo.

Woolshed—Mr. D. McLennan's, Marnoo.

Mr. R. Miller's crop of 70 acres of Federation was remarkably well-headed, unusually deep in colour and possessed exceptional "bloom." The same characteristics were not observed in the wheat from an adjoining paddock on the same farm, and there was apparently nothing to account for the distinctive appearance of the crop except that it was sown with only 56 lbs of wheat per acre. This had the effect of rendering it less dense than is usually considered desirable. The paddock was

summer-fallowed, prepared in March with a scarifier and subsequently worked only with the scarifier, harrows and spring-tooth. It was sown with a combined-drill during the first week in July—120 lbs. of superphosphate an acre were used.

DETAILS OF AWARD. SECTION 2—60 ACRES OF WHEAT IN ONE PADDOCK

Name.	Yield.	Trueness to Type.	Absence of Weeds.	Absence of Disease.	Evenness.	Total.
Possible Points ..	**35**	**20**	**15**	**15**	**15**	**100**
Carra Bros.	34	20	13	15	14	96
James Crampton ..	33	19	13	15	15	95
W. Newall	35	19	11	15	14	94
R. Miller	30	20	14	15	15	94
C. McAllister ..	35	13	15	15	15	93
R. Jackson	29	19	15	14	15	92
C. McAllister ..	28	17	13	15	15	88
J. Sweetman ..	30	19	10	15	14	88
W. H. Kendall ..	28	17	12	14	15	86
J. P. Loats	27	19	12	14	13	85
D. McLennan ..	25	17	12	14	15	83
A. Graham	26	19	12	13	13	83
Brown Bros.	22	19	14	11	15	81
J. Dunlop	26	19	9	13	14	81
W. J. Hemphill ..	21	19	11	12	15	78
G. Hemphill	20	19	10	14	15	78
G. Miller	27	20	8	11	11	77
A. R. Dunlop ..	21	20	8	13	13	75
R. Duncan	20	19	11	12	12	74

NOTE.—The points for yield do not represent bushels. The difference between them do. The highest yield was estimated at over 15 bags per acre.

RESULTS—SECTION 4A. FOR REPATRIATED SOLDIERS.

Wheat Crop on whole of fallowed land.

Mr. A. G. Swan was awarded first prize and 90 marks for an excellent crop of Federation wheat 120 acres in extent. The wheat was short, dense, and free from weeds. The land which was portion of the Warranooke Sheep Station was ploughed up in July and August, and twice harrowed in early September. It was scarified in October, and harrowed twice immediately afterwards. After harvest it was harrowed in March, spring-toothed-up with the combination drill and harrowed in May. Seventy lbs. of Federation wheat and 93 lbs. of superphosphate per acre were drilled in with a combined spring-toothed cultivator drill in June and July.

Mr. N. A. McLellan was second with 88 points. The crop was sown in May and June, from 75 lbs. to 80 lbs. of seed per acre and 93 lbs. of superphosphate being used.

Mr. E. T. Kendall's crop was a heavy one, but points were deducted for the presence of mustard and wild oats. The paddock contains some splendid black soil. The fallow was well-worked winter-fallow. Portion of Mr. J. H. Bates' crop was the heaviest grown by a returned soldier, but unfortunately the seeding of the balance, some 40 acres, was delayed until August with consequent reduction in yield.

DETAILS OF AWARD—SECTION 4A—FOR RETURNED SOLDIERS.

Wheat crop on whole of fallowed land.

Name.	Yield.	Trueness to Type.	Absence of Disease.	Absence of Weeds.	Evenness.	Total.
Possible Points ..	**35**	**20**	**15**	**15**	**15**	**100**
A. G. Swan	30	19	15	14	12	90
N. A. McLennan ..	27	18	14	15	14	88
G. C. Baylie ..	24	19	15	13	12	83
E. T. Kendall ..	30	18	12	10	12	82
J. H. Bate	29	16	15	12	10	82

A Returned Soldier's Crop on the Warranooke Estate, Rupanyup.

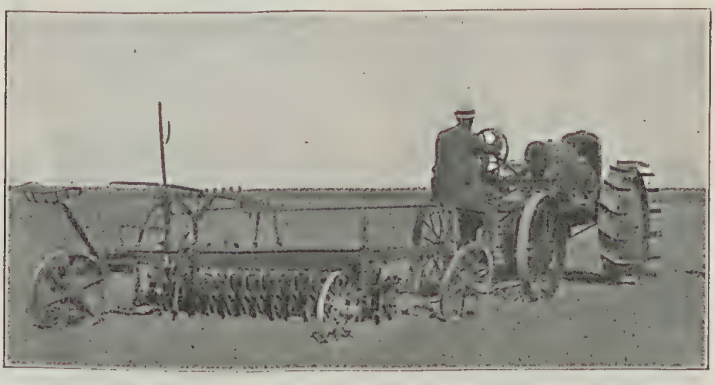
Fallowing Methods.

Each year the practice of summer-fallowing is proving more and more popular on the friable Wimmera soils. Farmers have found that the system pays. In former reports the convenience of summer-fallowing has been referred to at some length. The general success of the summer-fallowed crops in the competitions this year is further proof, if any is needed, that the practice also gives heavier yields. But it is not a good policy in point of convenience to attempt to prepare the whole of the fallow land as summer-fallow. Rather is it preferable to treat from 50 to 60 per cent. only in this way.

Now that the value of thorough tillage of the fallow while in a moist condition is so generally appreciated in the Wimmera, considerable interest is being manifested in methods of cultivation. A fallow consisting of some 2½ inches of loose mellow soil overlying a level, firmly-consolidated seed-bed is the accepted ideal. How to achieve that condition most economically is a debatable point. The orthodox method is to plough the land with a set-plough in March or April if summer-fallow, or July and August, if winter-fallow, then scarify the paddock as weeds appear, with an occasional harrowing. Usually two scarifyings

are required, say in September and October, and two before the crop is sown in the autumn. As a matter of general observation, the crops grown on land double-scarified both in spring and autumn are generally more prolific than those once treated. The harrows, as a rule, follow the original ploughing and each scarifying. Some, like Mr. Newall, go further and harrow twice after each scarifying. Harrowing in February and March, should rain fall, is fairly general and in many instances there appears to be conclusive evidence of its value to the succeeding crop. Its value is especially noticeable in dry years. Now that the combined spring-tooth cultivator drill has become so popular, many farmers are using it to work over their fallows on all occasions where the weeds are too vigorous for the harrows, and where the soil is not firm enough, or weeds bad enough, to require a scarifier.

The skim-plough does not do such good work as the scarifier, and has practically being dispensed with on the black soils in the Wimmera. It does not cut rubbish as efficiently as the scarifier.



Discing "paddy-melons" on the fallow with disc cultivator drawn by tractor.

On some of the lighter soils, especially in the vicinity of Warracknabeal, a good deal of the fallow is prepared without the aid of the plough at all. Some of the crops so prepared at Warracknabeal this year were not as satisfactory as they might have been, but this was probably unconnected with the non-use of the plough, for, provided the work is done to a sufficient depth, the soil is cultivated just the same. Anyhow the plough in the sticky black soils of the Wimmera does little more than push the soil aside. There is no question of turning a sod. Some of Mr. Jackson's best crops have been grown without the aid of a plough. Of course, the continued use of this method will in a few years lead to increasing difficulty in securing a satisfactory depth of cultivation, owing to the gradual consolidation of the soil. Then recourse must be made to the plough.

The Fallows.

Patchy rain having fallen immediately prior to the judging of the crops in December, the inspection of the fallows was deferred till March.

In all eleven competitors submitted their fallows for inspection. All the entries were most meritorious, and were of such an even standard of excellence that there was considerable difficulty in separating the competitors. The test was, however, a most severe one, as no rain had fallen for three months, hence none but a well-mulched fallow could be expected to contain moisture. Yet all proved to have ample supplies. Indeed, in many cases at a depth of 8 inches, the clay loam was so moist that it could be moulded like putty in the hand. In general, where the most moisture was found, there the greatest skill had been displayed in cultivating the land. As a rule, the earlier the initial ploughing the moister the soil. Thus summer-fallowed paddocks were generally moister than those winter-fallowed. Another feature that most of the best fallows had in common was that the spring scarifying had been done in September—not delayed until late in October or early November. The early spring scarifying with its accompanying stroke or two of the harrows appears to be most effective in pugging together

Cutting "paddy-melons" on fallows at Rupanyup with "knife" attached to scarifier.

the loose black soil at a depth of 2 or 3 inches, so that a firm, well-packed seed-bed is formed.

Almost all the fallows exhibited were free from weeds, but some others in the district were infested with paddy melons. While it is often claimed that good crops follow paddy melons, it is very probable that better crops will result if they are removed by harrowing while they are in the seedling stage. The V-shaped knife, if properly constructed and fitted to the scarifier will cut them when mature, but the vines may get entangled round the "feet" supporting the knife. Disc coulters may be fitted in such a way as to cut the plants into suitable lengths, and thus prevent the vines clinging to the knife and ridging the land. The disc cultivator is an objectionable implement to use on a fallow for cutting paddy melons late in the season. With it, it is difficult to avoid destroying the consolidated condition of the under layers of soil. Some fallows were noticed showing signs of extensive cracking. Harrowing is useful as a preventive.

Mr. C. Caira's Teams Summer-fallowing (Rupanyup).

Results.

Mr. A. Edmunds has been awarded 99 points and first place for an almost perfect fallow at Marnoo. The moisture content was exceptionally high, weeds were entirely absent, and the consolidation and the general level character of the soil at a depth of 2 inches were excellent. The mulch was fine and mellow, though a trifle shallow. The excellence of the fallow is attributable to the judgment with which it has been prepared and cultivated.

It was summer-fallowed with a scarifier in March, and then ploughed with a set-plough in June and harrowed. In September, it was scarified and then harrowed twice. Two further scarifyings were given in November as rubbish appeared. Subsequently three additional strokes of the harrows were given. In all, there were eleven different operations involved in creating and maintaining the fallow up to the end of March. Seeded with judgment, it should grow an excellent crop.

Mr. R. T. Jackson, of Burrereo, the winner of the Brunton Cup last year, secured 96 points and second place. The fallow was not quite as high in moisture as that of the winner, but had an excellent mellow mulch, though like that of the winner, a trifle thin. The soil below the loose mulch was notably level and consolidated. The paddock, 180 acres, was ploughed to 4 inches deep in July and early August, then harrowed twice. In early October it was scarified, then harrowed. It was harrowed in January and again in February.

Portion of Mr. W. J. Hemphill's fallow was summer-fallowed in March to 4 inches, and portion winter-fallowed. Both paddocks were well worked.

Mr. J. P. Loats exhibited three paddocks, all of which were exceptionally well worked.

Mr. W. Newall's fallow had been worked over in all eleven times.

DETAILS OF AWARD.

Best half of Farmer's Fallowed Land.

Name.	Mulch.	Moisture.	Weeds.	Cultivation.	Total.
Maximum Points	25	25	25	25	100
A. Edmunds	25	24	25	25	99
R. J. Jackson	23	23	25	25	96
W. J. Hemphill	23	23	25	24	95
J. P. Loats	22	23	25	24	94
W. Newall	22	22	25	24	93
John Sweetman	22	21	25	23	91
C. Carra	22	21	25	22	90
G. H. Kennedy	22	21	25	21	89
W. H. Kendall	23	20	22	24	89
A. Dunlop	20	22	24	20	86
A. Graham	22	20	20	20	82

WEEDS AND THEIR ERADICATION.

(Continued from p. 319.)

By H. W. Davey, F.E.S., Orchard Supervision Branch, Department of Agriculture.

Thorn Apple, *Datura Stramonium,* L. **Family:** *Solanaceæ.*

This common rank-smelling annual is supposed to have come originally from India, but is now almost a cosmopolitan species, and has a wide distribution in this State.

It has a partiality for good soils in which it will grow into a large, bushy herbaceous plant, sometimes 3 feet in height. It has large, irregular-shaped leaves. Solitary, short-stalked, long funnel-shaped flowers arise at the base of branches; these flowers are large, white-coloured, and conspicuous.

The prickly, oval seed capsules (Fig. 64), which the datura bears makes the plant easy of recognition.

In common with some others of the same genera, it is a highly poisonous plant, its seeds especially so, the toxic principle being Daturnine.

The inhalation of the smoke given off in the burning of the dried leaves of this plant is claimed to afford great relief to persons suffering from asthma.

This Datura may be easily suppressed by good cultivation, but care should be taken to prevent isolated plants from seeding; this may be done by hand-pulling them, or mowing them close to the ground before the seeds of the earliest capsules have ripened.

It is proclaimed under the Thistle Act for the whole State of Victoria.

Fig. 64.—**Thorn Apple,** *Datura Stramonium*, L.

Blue Devil or Blue Eryngo, *Eryngium rostratum*, Cav. Family: *Umbelliferæ.*

This common spiny-leaved plant belongs to a genus that has a very wide distribution. Many species are both ornamental and beautiful; over forty have been described from different parts of the world, most of which are perennnials.

Our common native Eryngo, with its thistle-like flower heads of a blue colour, is a pretty species. Its stiff, spine-like leaves, make it an awkward plant to handle.

Fig. 65.—Blue Devil or Blue Eryngo, *Eryngium rostratum*, Cav.

The Blue Eryngo appears to have increased very much during the last few seasons in some localities, especially on grass lands. It should therefore be looked upon as an undesirable, and hoed or mattocked out before it has ripened its seed.

This plant can easily be recognised from the accompanying illustration (Fig. 65).

(To be continued.)

STANDARD COWS.

Report on Herd Testing for Quarter ended 31st March, 1923.

Number of cows which completed the list during the quarter, 188. Number which qualified for a certificate, 150.

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk last Day.	Milk.	Average Test.	Butter Fat.	Standard Required.	Estimated Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
Mrs. I. Alston, Estate, Cobram	4	4	Jersey ..	Pidgeon of Kameruka ..	6035	31.3.22	273	15½	6,585	6·04	397·95	250	453¾	384, 356, 409
				Romany Girl 3rd of Tarnpirr	Not yet allotted	13.5.22	273	11	4,670	6·41	299·48	200	341¼	
				Bonnie Annie of Aberdour ..	..	20.5.22	273	13	4,178	5·43	226·78	175	258¼	
				Welcome of Tarnpirr ..	7069	27.5.22	273	16	5,428	6·45	350·20	250	399¼	411
J. Anderson, junior, Lyndhurst	1	1	Jersey ..	Lady Monica 12th	Not yet allotted	4.6.22	273	14	5,214	5·99	312·57	175	356¼	
W. K. Atkinson, Swan Hi	2	2	Shorthorn	Cherry 2nd of Willow Park..	Not yet allotted	12.6.22	273	8½	4,304	4·25	182·83	175	208½	
				Bloom of Willow Park ..	..	19.6.22	273	22½	7,621	3·83	292·03	175	333	
C. Bamford, Benalla	11	11	Ayrshire	Bloomer of Medburn Grove ..	8298	8.4.22	273	16	6,977	4·28	298·52	200	340¼	209
				Bonza of Medburn Grove ..	Not yet allotted	12.4.22	273	15	6,500	3·69	240·00	175	273½	
				Babe of Medburn Grove ..	6106	17.4.22	273	32½	11,921	3·99	475·22	250	541¾	283, 363
				Annie 2nd of Medburn Grove..	Not yet allotted	17.4.22	273	17	6,507	4·23	275·06	175	313½	
				Linda of Medburn Grove ..	8303	18.4.22	273	23½	9,059	3·92	355·47	200	405¼	284
				Bertha of Medburn Grove ..	Not yet allotted	19.4.22	273	10½	5,840	4·45	259·91	175	296½	
				Spot of Medburn Grove ..	8313	26.4.22	273	11½	6,449	4·45	286·78	200	291	265
				Lady Mac of Medburn Grove..	Not yet allotted	6.5.22	273	19½	6,670	4·40	296·15	175	337¾	
				Pansie of Medburn Grove ..	4860	8.5.22	273	11	9,259	3·98	368·43	250	420	319, 338
				Lupin of Medburn Grove ..	4859	19.5.22	273	14½	8,536	3·89	332·10	250	378½	201, 282
				Miss Mac of Medburn Grove ..	Not yet allotted	21.6.22	273	11½	6,066	4·33	262·63	175	299½	

STANDARD HERD TEST—*continued.*

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk last Day.	Milk.	Average Test.	Butter Fat.	Standard Required.	Estimated Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
A. E. Batson, Buckley	1	1	Jersey ..	Defender's Queen of Somerset	Not yet allotted	1.4.22	273	15	4,405	4·89	215·23	175	245¼	
Mrs. Irene Beard, Outtrim	1	1	Jersey ..	Brilliance of Kelburn ..	Not yet allotted	14.5.22	273	18	5,681	5·45	309·49	175	353	
J. Benallack, Elliminyt	2	1	Ayrshire	Adele of Cororooke House ..	7045	28.4.22	273	12½	4,549	4·05	184·21	175	210	
F. Bidgood, Staghorn	1	1	Jersey ..	Favourite 2nd of Staghorn ..	Not yet allotted	17.4.22	273	8½	4,494	4·65	209·17	175	238½	
Mrs. Agnes Black, Noorat	6	5	Jersey ..	Noorat Beauty*	6408	13.4.22	273	15	7,232	4·53	327·42	250	373¼	256, 340
				Noorat Marguerite	6413	22.4.22	251	4	7,654	4·94	377·99	250	432	211 356, 388
				Flashlight	1972	1.5.22	233	4	5,734	5·48	314·29	250	358½	294, 297, 268
				Noorat Peach	9218	27.5.22	273	8½	5,568	5·22	290·88	175	331½	
				Shiela 5th	3580	10.6.22	273	10	5,209	4·92	256·24	250	292¼	215, 253, 257
A. A. Broad, Sutton Grange	1	1	Jersey ..	Roma of Hillcrest	7028	20.6.22	273	21½	8,723	4·32	376·53	250	429¼	
Callery Brothers, Bannockburn	1	1	Ayrshire	Roseleaf of Langley Park ..	4953	11.6.22	273	17½	8,676	4·54	393·84	250	449	285, 286
R. C. Campbell, Clarendon	1	1	Jersey ..	Queenie of Springvale ..	Not yet allotted	24.5.22	273	7½	4,745	5·95	282·50	175	322	

* Identical with Beauty of Condelo 3rd under which name she was previously tested.

STANDARD HERD TEST—*continued.*

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk Last Day.	Milk.	Average Test.	Butter Fat.	Standard Required.	Estimted Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
Mrs. M. E. Carroll, Tyntynder Central	1	1	Red Poll	Carolina	346B	17.6.22	273	10	4,873	4·30	209·73	175	239	
D. C. Cayley, Werribee	3	3	Ayrshire	Irene of Banyule	10221	21.4.22	264	4	6,888	4·00	275·51	250	314	
				Bloom of Banyule	6750	26.4.22	273	9½	7,467	4·22	315·19	200	359½	
				Princess Thyra 4th of Strachan	6125	1.5.22	270	4	8,250	3·55	292·92	250	334	
P. Chirnside, Oakleigh	2	2	Jersey ..	Fox's Golden Cream ..	4722	6.4.22	273	16½	6,296	4·78	301·26	250	343½	
				Werribee Starbright 8th ..	6543	15.6.22	273	18	7,704	4·72	363·75	250	414¾	
W. T. Cullen, Warrion	3	2	Ayrshire	Dime of Riccarton	6496	10.5.22	235	4	5,422	4·96	269·15†	250	306¾	257, 260
				Docy of Riccarton	6497	24.5.22	248	4	7,111	3·78	269·12	250	306¾	257, 233
A. E. Denis, Swanpool	4	4	Jersey ..	Marise of Tarnpirr	Not yet allotted	1.5.22	256*	17½	5,176	5·16	267·03	175	304½	
				My Hope of Kameruka ..	6032	6.6.22	273	11	6,206	4·67	289·66	250	330¾	335, 336, 392
				Mistletoe 2nd of Tarnpirr ..	6030	17.6.22	273	11	7,592	5·42	411·54	250	469½	450. 432
				Rarity 13th of Melrose ..	Not yet allotted	19.6.22	273	12	4,658	5·50	256·00	175	292	
Department of Agriculture	6	5	Red Poll	Battle Smoke	289B	1.4.22	235‡	16½	4,727	4·15	196·06	175	223½	
				Toronto	326B	4.4.22	273	19	6,160	4·32	265·97	250	303¾	210, 210
				Cutty	490D	19.4.22	240	7	5,910	4·50	265·90	250	303	287, 388, 454, 443, 442, 450
				Corona	382C	4.5.22	198*	16½	5,484	3·94	216·05	200	246½	237
				Hookah	392C	7.5.22	273	14	7,474	3·99	298·54	250	340¾	244
	1	1	Friesian	Victoria Dutch Maid ..	Not yet allotted	23.5.22	273	9	6,351	3·85	244·30	200	278¾	242

* Withdrawn before completing full term. † Short test because of mammitis ‡ Sold before completing full term.

STANDARD HERD TEST—*continued.*

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk Last Day.	Milk	Average Test.	Butter Fat.	Standard Required.	Estimated Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
Department of Agriculture	1	1	Jersey ..	Collingwood's Beauty ..	6749	28.3.22	273	19¼	6,015	6.40	384·98	250	439	357, 257
C. Deverell, Wangaratta	3	3	Jersey ..	Gold Bell of Methven ..	9293	28.3.22	273	38	10,995	4·60	516·22	200	588½	413
				Lantana 2nd of Springhurst ..	Not yet allotted	30.4.22	273	19½	6,018	6·23	374·74	175	437¼	
				Brighton Princess of Springhurst	5391	13.5.22	273	15	9,138	4·82	440·69	250	502½	293, 270, 281, 509
C. Falkenberg, Elliminyt	4	2	Jersey ..	Hope 5th	2899	14.5.22	273	10	5,653	5·31	299·98	250	342	349, 372
				Empire 8th of Melrose ..	Not yet allotted	17.6.22	273	4	4,107	5·24	215·14	175	245¼	
R. Faragher, Koroit	3	3	Jersey ..	Bright Jewell 2nd of St. Albans	5980	4.4.22	273	7	3,517	6·13	215·54	175	245¾	
				Clover of Saranac	9313	21.4.22	268	5	5,426	6·71	364·06	200	415	327
				Belle A	6315	21.4.22	273	8½	4,688	5·90	276·41	250	315¼	305
Flack and Sewell, Berwick	7	7	Friesian	Burnbank Woodcrest Segis ..	1085	28.3.22	273	26	10,669	3·62	386·34	175	440¼	
				Dominion Queen Mercedes ..	262	12.4.22	273	46½	15,958	3·69	589·53	250	672	352, 330
				Ashlyn 58	Not yet allotted	21.4.22	210	26	6,103	4·36	266·03	175	303¼	
				Monovale Amethyst Paxton ..	148	7.5.22	272	13	8,855	4·13	365·44	250	416¾	
				Burnbank Mercedes Flower ..	486	9.5.22	270	10	4,515	3·95	178·18	175	203¼	
				Springfield White Posch ..	Not yet allotted	29.5.22	273	17½	7,612	3·89	295·80	200	337¼	217
				Burnbank Mercedes Violet ..	487	13.6.22	273	9	8,632	3·34	288·03	175	328¼	
Mrs. M. and W. A. Francis, Kilcunda	1	1	Ayrshire	Rose of Hillcrest	9079	24.5.22	273	6½	4,592	4·59	210·79	175	240¼	

STANDARD HERD TEST—*continued.*

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk Last Day.	Milk.	Average Test.	Butter Fat.	Standard Required.	Estimted Butter.	Previous Yields of Butter Fat
								lbs.	lbs.		lbs.	lbs.	lbs.	
G. Gange, Mininera	4	2	Ayrshire	Azelia 2nd of Ferndale ..	5931	29.3.22	273	12	5,360	4·91	263·23	200	300	
				Alvie of Roseleigh	7296	4.5.22	273	20	8,023	4·41	353·54	250	403	331
N. Gange, Mininera	3	2	Ayrshire	Petunia of Glencairn ..	4417	31.5.22	273	18	8,998	3·96	355·88	250	405¾	318
				Flower of Roseleigh ..	7299	15.6.22	249	4	5,274	4·16	219·44	200	250¼	200
H. S. Gibson, Murraydale	2	2	Ayrshire	Dairymaid of Evergreen ..	7317	12.6.22	273	15½	6,583	4·00	263·53	200	300¼	
				Flo of Evergreen	Not yet allotted	18.6.22	273	11½	6,161	4·54	279·87	175	319	
R. Goodman, Kilmany South	2	1	Ayrshire	Flora of Roseneath ..	9132	1.4.22	273	15	5,769	4·35	250·75	250	286	
D. F. Griffiths, Inverleigh	3	3	Ayrshire	Nora of Gowrie Park ..	5184	4.4.22	256	4	6,166	4·24	261·41	250	298	
				Pearce's Heather of Struan Park	Not yet allotted	7.5.22	273	14	5,290	4·49	237·75	175	271	
				Royal Heather of Gowrie Park	5186	19.5.22	273	19½	8,914	3·56	317·74	250	362¼	
R. Hall, Sale ..	1	1	Ayrshire	Violet's Queen of Dunachton..	2922	17.4.22	273	16½	8,322	3·74	311·16	250	354¾	271
T. Harvey, Boisdale	3	3	Jersey ..	Kirsty 8th of Jerseyholm ..	6846	1.4.22	273	18	8,226	5·66	465·89	250	531	305, 395
				Kirsty 6th of Jerseyholm ..	4980	7.4.22	273	19½	7,142	6·18	441·73	250	503½	347, 447, 414
				Empress of Jerseyholm ..	9393	8.6.22	273	18½	8,952	5·86	524·44	200	598	400
A. E. Haughton, Heidelberg	1	1	Jersey ..	Laane's Fancy of Fairview ..	9397	20.5.22	273	17½	5,288	4·99	264·04	200	301	183

STANDARD HERD TEST—*continued.*

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk Last Day.	Milk.	Average Test.	Butter Fat.	Standard Required.	Estimted Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
Dr. and Mrs. Henderson, Wangaratta	4	Nil	Jersey ..											
	1	Nil	Red Poll											
W. Henderson, Grasmere	2	Nil	Ayrshire											
J. H. Hunter, Tyntynder Central	3	3	Jersey ..	Chevy 12th of Melrose ..	6941	30.4.22	180*	26	5,635	6·22	350·32	250	399½	362, 456
				Rarity 11th of Melrose ..	6944	7.5.22	162*	24½	5,964	5·60	334·01	250	380½	365, 403
				Peerless of Meadowvale ..	9408	29.5.22	151*	18	3,757	5·51	207·13	200	236	272
A. W. Jones, Whittington, near Geelong	7	7	Jersey ..	Maid 2nd of Linden ..	8437	15.4.22	273	13½	4,631	5·90	273·03	175	311½	
				Fuchsia 13th of Melrose ..	6300	26.4.22	273	24	8,264	4·64	383·70	250	437½	355, 407, 439
				Lilac of Tarnpirr	6028	4.5.22	273	15	5,970	4·81	287·37	250	327½	325, 424
				Mermaid 2nd of St. Albans ..	Not yet allotted	12.5.22	273	14½	4,285	5·50	235·85	175	269	
				Thelma of Meryula ..	5473	9.6.22	273	21½	8,139	4·97	404·64	250	461½	
				Lady Grey 1st of St. Albans..	4186	25.6.22	273	17	4,353	6·08	264·80	250	301½	347, 409, 404, 466, 529, 464, 385
				Beautie of Tarnpirr ..	6023	25.6.22	273	13½	6,432	6·29	404·53	250	461½	346, 475, 486
	6	6	Friesian	Melba	Not yet allotted	9.4.22	273	30	9,348	3·49	326·17	250	371½	299, 366, 339
				St. Alban's Gem	358	11.4.22	273	28	12,721	3·31	431·22	250	491½	312, 376
				Bloomfield Mutual Lassie ..	1037	14.4.22	273	10	7,785	3·83	297·84	175	339½	
				St. Alban's Daisy	1038	5.5.22	273	21½	6,495	3·69	240·03	175	273½	
				Nora's Pearl	363	27.5.22	269*	26	9,347	3·23	301·79	250	344	284, 354
				Bolobek Rose	319	29.5.22	273	22	9,840	3·54	346·20	250	394½	284, 423, 449, 378

* Sold before completing full test.

STANDARD HERD TEST—*continued.*

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk Last Day.	Milk.	Average Test.	Butter Fat.	Standard Required.	Estimted Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
Kerr Bros., Bacchus Marsh	5	4	Shorthorn	Morven Cressida	Not yet allotted	20.5 22	273	26	9,000	4·08	367·60	250	418	292
				Lady Hayle 7th	,,	3.6.22	273	17½	6,451	3·69	237·51	175	271	
				Morven Duchess 14th ..	,,	15.6.22	273	7½	8,766	3·60	315·47	250	359½	250, 290
				Morven Lizzie 7th	,,	17.6.22	273	10½	7,204	4·02	289·67	250	330¼	251, 258
A. Kirby, Daylesford	3	3	Ayrshire	Ada of Wattlebank ..	5311	6.4.22	273	15	5,731	4·45	255·11	250	291	240
				Lily of Wattlebank ..	9686	16.4.22	273	17½	5,722	4·47	256·05	175	292	
				Pride of Wattlebank ..	5315	21.5.22	273	19½	7,819	4·42	345·58	250	394	272
C. Lees, Lockington	1	1	Ayrshire	Heather of Range View ..	6658	28.3.22	273	14½	5,939	4·61	273·77	200	312	
H. Luxton, Whittlesea	3	3	Jersey ..	Lady Lene of Elouera ..	9702	11.4.22	273	23	6,008	5·02	301·33	175	343½	
				Syringa of Springhurst ..	9665	17.5.22	273	8	4,502	6·24	280·87	200	320½	221
				Grevillea of Springhurst ..	9655	17.5.22	273	22	6,806	5·87	399·27	200	455¼	
C. G. Lyon and R. R. Kerr, Heidelberg	2	1	Jersey ..	Hawthorn 5th of Banyule ..	5208	20.5.22	273	14½	7,162	5·22	373·96	250	426¼	286, 368, 394, 292
W. Macauley, Rochester	1	1	Jersey ..	Honey of Wanalta	7164	2.4.22	273	18½	5,552	4·95	274·64	200	313	269
R. H. Maher, Tongala	1	1	Jersey ..	Peerless 20th of Melrose ..	9897	16.6.22	273	13	6,130	5·49	336·24	250	383¼	361
W. Meredith, Ondit	2	2	Ayrshire	Lilian of Willowvale ..	4650	25.4.22	273	6	7,287	4·28	311·75	250	355½	298
				Elsa of Willowvale	5360	24.5.22	251	4	5,268	4·85	255·75	250	291½	247

STANDARD HERD TEST—*continued.*

Owner.	No. Completed.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk Last Day.	Milk.	Average Test.	Butter Fat.	Standard Required.	Estimted Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
C. G. Newton, Kilmany South	1	1	Ayrshire	Peggy 3rd of Summerhill ..	5325	23.6.22	266	4	6,191	4·01	253·16	250	288½	262, 267
Mrs. Lilian Orchard	7	Nil	Jersey ..											
J. Platfuss, Tongala	1	1	Friesian	Westmere Oakwood Piebe ..	601	1.6.22	273	45	11,620	3·27	380·45	175	433¾	
F. Raggatt, Casterton	1	1	Jersey ..	Lassie 4th of Clover Flat ..	5485	29.5.22	273	16½	8,730	4·76	415·56	250	473¾	295, 357, 366, 307
R. Ralston, Moglonemby, near Euroa	3	3	Ayrshire	Opal of Ben Kell	6741	11.4.22	273	9	5,893	4·14	243·83	175	278	
				Begonia of Ben Kell ..	6730	5.5.22	273	13	5,951	4·17	248·35	175	283½	
				Pearl of Ben Kell	3052	28.5.22	273	11½	7,658	4·02	307·96	250	351	337, 281, 326
J. D. Read, Springhurst	7	7	Jersey ..	Tuberose of Springhurst ..	Not yet allotted	3.4.22	273	26	6,127	5·07	310·86	175	354½	
				Belladonna of Springhurst ..	5389	4.4.22	273	22½	6,724	4·55	306·26	250	349¼	222, 253, 399
				Nightshade of Springhurst ..	3707	10.4.22	273	25½	8,095	4.58	371.12	250	423	297, 230, 410, 419, 425, 421, 283, 455
				Cornflower of Springhurst ..	7326	22.5.22	273	23	7,976	5·37	427·96	250	477¾	243, 385
				Clover of Springhurst ..	6201	24.5.22	273	10	6,640	5·34	354·62	250	404¼	263, 206, 366
				Boltonia of Springhurst ..	9449	10.6.22	273	16½	5,755	5·12	294·40	200	335¼	218
				Countess 2nd of Springhurst	9651	16.6.22	273	13	6,398	5·40	345·23	200	393½	290
Miss Bruce Reid, Bundoora	2	2	Jersey ..	Jubilee Rosemary	Not yet allotted	5.5.22	273	16	4,894	5·00	244·79	175	279	
				Jubilee Periwinkle	9673	8.6.22	273	11½	4,453	5·86	261·02	250	297½	210

STANDARD HERD TEST—*continued.*

Owner.	No. Completed Test.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk last Day	Milk.	Average Test.	Butter Fat.	Standard required.	Estimated Butter.	Previous Yields of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
C. J. Reid, Devenish	1	1	Jersey ..	Fuchsia 12th of Melrose ..	6299	9.4.22	273	10½	6,868	4·86	333·85	250	380½	292, 361, 397
Miss S. L. Robinson, East Kew	4	2	Jersey ..	Sweet Pansy of Fairview ..	9681	12.6.22	273	4½	4,732	4·94	234·74	200	267½	
				Rocket of Ruhbank ..	9348	12.6.22	273	4½	3,367	5·99	201·76	200	231	182
F. G. Sadler, Camperdown	6	3	Shorthorn	Holly Queen of Pentland 4th	Not yet allotted	28.4.22	249	4	9,008	3·96	356·31	250	406½	306
				Pansy of Hillcrest	,,	4.6.22	273	10	4,454	4·26	189·95	175	216½	
				Daphne of Hillcrest	,,	6:6.22	273	7½	6,615	4·03	266·76	200	304	
Sadler Bros., Noorat	1	1	Ayrshire	Fairlie of Burnbrae ..	4609	13.4.22	196*	27	6,342	4·37	276·90	250	315¼	321, 338
A. H. S. Schier, Kernot	3	2	Ayrshire	Myrtle 2nd of Pine Grove ..	4637	7.4.22	273	18	7,513	4·10	307·99	250	351	282, 264, 298
				Marguerite of Glengowrie ..	4632	27.4.22	273	20	6,670	4·65	310·12	250	353½	205, 247, 280
O. J. Syme, Macedon	6	6	Friesian	Bolobek Dorothea	Not yet allotted	10.4.22	260	13	4,870	3·80	184·82	175	201¾	
				Domino's Hengerveld Belle ..	307	17.4.22	273	30	11,963	3·60	430·29	250	490½	311, 398, 446, 415
				Bolobek Judith	Not yet allotted	24.4.22	246	22½	8,331	3·38	281·53	175	321	
				Princess Ena	299	15.5.22	273	18	9,470	3·41	322·99	250	368¼	384, 442, 424, 371
				Bolobek Jean	320	20.5.22	273	17½	9,539	3·48	331·68	250	378	249, 359, 337, 419
				Bolobek Anabel	317	24.5.22	273	7	9,440	3·87	365·30	250	416½	305, 390, 380
J. R. Telford, Kyabram	1	1	Ayrshire	Daisy of Hyde Park ..	6916	7.6.22	273	17	6,232	4·09	255·16	175	290¾	

* Herd withdrawn before full test completed.

STANDARD HERD TEST—*continued.*

Owner.	No. Completed Test.	No. Certificated.	Breed.	Name of Cow.	Herd Book No.	Date of Calving.	Days in Test.	Milk last Day	Milk.	Average Test.	Butter Fat.	Standard required.	Estimated Butter.	Previous Yields. of Butter Fat.
								lbs.	lbs.		lbs.	lbs.	lbs.	
J. H. Thorburn, Woodend North	1	Nil	Ayrshire											
G. Vallance, Bacchus Marsh	1	Nil												
A. L. Walters, Little River	1	1	Jersey ..	Flower 14th of Melrose ..	Not yet allotted	14.5.22	273	15½	6,099	5·84	356·40	200	406¼	334
Warrnambool High School, Warrnambool	2	Nil	Ayrshire											
H. L. Webb, Sunbury	1	1	Ayrshire	Model of Holly Green ..	6953	22.4.22	273	15	7,484	4·11	307·29	175	350¼	
W. Woodmason, Oakleigh	7	5	Jersey ..	Zoe 6th of Melrose	Not yet allotted	7.4.22	273	15	4,785	6·13	293·35	175	334½	
				Lady Elector 2nd of Melrose..	5548	18.4.22	273	9½	5,144	5·93	305·23	250	348	263, 360, 395, 421, 309, 361
				Waverley Lass 3rd of Melrose	6312	24.4.22	273	16	6,282	6·41	402·61	250	459	269, 350, 395, 392
				Graceful Duchess 10th of Melrose	3646	1.6.22	273	21	8,009	5·82	466·48	250	531¾	283, 337, 446, 440, 448, 353, 338
				Lady Elector 10th of Melrose	Not yet allotted	7.6.22	273	10½	4,092	6·03	246·81	175	281½	

EXPERIMENTS IN THE STORAGE OF FRUITS.

(*By D. B. Adam, B.Agr.Sc., Department of Agriculture.*)

(Continued from page 241.)

APPLES.

In the previous article on apple storage in this journal (*April*, 1923), it was decided to consider the causes of loss in cool storage, and examine, as far as possible, the effects of varying cool storage conditions on those causes. Of necessity, some consideration was given to the conditions under which the fruit was grown. So far scald and Jonathan spot have been discussed.

Internal Browning or Breakdown.

The phenomenon of internal breakdown is met with in many varieties of apples, yet it has not received much attention in the literature on the subject of the cool storage of fruits.

The Bureau of Plant Industry in the United States has investigated a similar, if not identical, trouble in stored apples, grown in the Pajaro Valley, California. Stubenrauch* found that browning was worse at 32° F. than at 34° F. Ballard, Magness, and Hawkins† have recently confirmed this observation, and have made further investigations into the relative importance of different orchard conditions. R. Waters,‡ under the title of "flesh collapse," has given some account of this trouble in New Zealand.

Two different types of internal browning may be distinguished immediately on the removal of fruit from store:—

(*a*) Where the fruit tissue cells themselves not only become brown, but the cells also become more easily dissociable from one another, which separation takes place on the application of pressure. The apple in part, or as a whole, becomes soft, and the trouble can be noticed without having to slice the fruit—a true breakdown—the "punky" or "sleepy" apple of the practical storeman.

(*b*) Where the tissue cells become brown, but the cells are not so readily dissociable from one another. The apple is quite firm, and the trouble generally cannot be noticed unless the fruit is sliced.

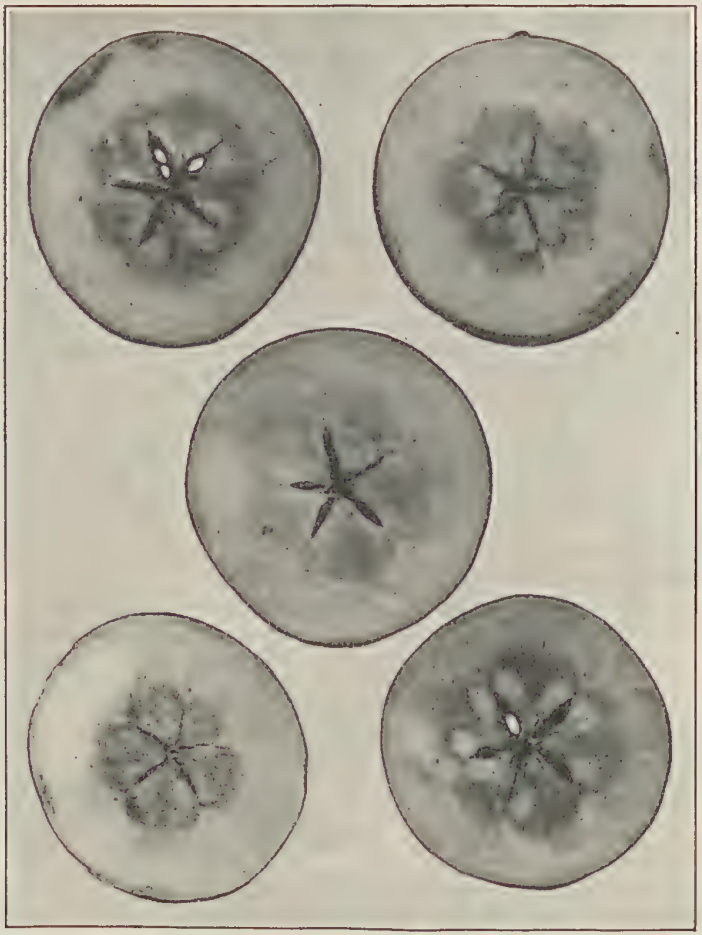
Consider first the type suggested in section (*a*).

It is an obvious fact that some varieties of apples differ markedly both in physical and chemical constitution from others.

Since the keeping qualities of any fruit are dependent on this constitution, it follows that some varieties do not keep as well as others. The Jonathan apple will not, as a rule, store for as long a period as a Yates apple will. Variations of constitution, however, are also found among apples belonging to the same variety. The constitution of an apple may be determined either by inherent or internal factors,

* Ice and Refrigeration, Vol. 42, No. 1, pp. 34-36, 1912.
† Bull. 1104, Bur. Plant. Ind., U.S.D.A.
‡ Ice and Cold Storage, Vol. XXV., No 295 p. 241, 1922.

such as the age of the tree on which the fruit is grown, the maturity of the fruit when picked, or to external environment, the climatic conditions, the situation of the tree, and soil conditions. Fruit picked off the young trees (other conditions being equal) will not store as well as fruit picked off old trees,



Internal Browning of Rymer Apples.

nor will fully matured fruit keep sound in store for such a long period as will less mature fruit. Apples grown on hillsides of slate or sandstone formation will keep better than the same variety grown on relatively rich, moist flats. The differences of keeping quality in each of these instances are almost directly proportional to the extent of development of internal browning. When, for any of

these reasons, an apple is susceptible to internal breakdown, a low storage temperature will tend to aggravate or facilitate its development.

Table VI. hereunder refers to the results of storing Rome Beauty apples for seven months. These apples were grown at Drouin on fairly low, well cultivated, moist, and relatively rich land. The fruit was stored at two different temperatures, and under different systems of refrigeration.

Table VI.—Rome Beauty Apples Grown at Drouin, Fully Mature; Storage Period, Seven Months.

Temperature.	Refrigeration System.	Internal Breakdown.	Sound.	Breakdown.	Average.
				%	%
32° F. ..	Direct expansion and air circulation	21	70	23	19
32° F. ..	Direct expansion ..	14	76	16	
34° F. ..	Direct expansion ..	17	92	14	
34° F. ..	Air circulation	10	65	13	13
34° F. ..	Direct expansion and air circulation	14	99	12	

Similar results in respect to another consignment of Rome Beauty apples are given in Table VII. These apples were also grown at Drouin, were less mature, and of larger grades, 3 inches to 3½ inches; trees situated on a hillside.

The results give the percentages of flesh collapse in each case. In this instance, indeed, as far as possible in all instances, the results for each case are given, so that the reader can himself judge the probable error, which, from the paucity of figures and limited experience, is necessarily large.

Table VII.—Rome Beauty Apples from Drouin, Large Grade; Storage Period, Seven Months.

Temperature.	Internal Browning in Cases.					Average.
	1.	2.	3.	4.	5.	
	%	%	%	%	%	%
32° F.	9·9	5·6	4·8	2·8	2·5	4·3
34° F.	4·0	2·8	..	..	..	3·4
37° F.	1·8	..	..	..	..	0·9

Both these tables indicate confirmation of results obtained elsewhere (Stubenrauch and Ballard, Magness and Hawkins), viz., that 32° F. is too low a temperature for ordinary storage purposes, especially in places where apples, by reason the variety, or its growth conditions, may be susceptible to flesh collapse. 34° F. gives better results than 32° F.; 37° F. is apparently better than either, where the results are gauged by the extent of internal browning in apples stored at these temperatures.

While considering this form of internal breakdown, careful handling, especially with tender varieties, should be remarked upon. The Jonathan apple is a tender variety. Some indirect evidence has been obtained as to the effects of handling; however, its incompleteness and the difficulty of analyzing what constitutes the abstract process called "handling," preclude its useful presentation here. Successful storemen recognise a relation between "sleepiness" and care in handling, bestowing particular attention in preventing the bruising of this variety. The maturer and larger the fruit is, the greater will be the necessity to exercise care in handling.

Although internal breakdown has been divided into two arbitrary sections, this is done rather from the idea of dissimilarity in naked eye appearance than from any theory as to the causes of each condition. In fact, all evidence rather tends to show that in these cool storage troubles a similar cause operates in each instance, and, since it conceivably affects different functions, it would produce different effects.

On somewhat similar grounds apples included in this second section are subdivided into—(*a*) those that show a generalized tissue browning; and (*b*) those that show a localized core browning. The core refers to a star-shaped piece of tissue surrounding the carpels or seed cavities. This core is bounded by a wavy line of demarcation of variable distinctness. It is more or less visible on transecting an apple. There is some evidence to show that this zone is frequently quite distinct, physiologically, from the rest of the apple (Bigelow, Gore, and Howard*).

The Rokewood apple, after long storage, is liable to a general tissue browning, whereas the variety Rymer shows a tendency to core browning; still the occurrence of either type of browning is not definitely a varietal characteristic. Some time after an affected Rokewood is removed from the store, it may become soft. This softness is, however, distinct from the "mealy" softness of apples previously described. The softened apple, while browned, is more springy. The cells themselves as individuals are more or less disturbed, but they are not so readily detachable from one another as is the case with "mealy" apples. Unfortunately, the susceptibility of this variety was not previously known, so that examination and observations were limited to half-a-dozen cases stored at 32° and 34° F. The fruit was stored for seven months. The following general observations may be recorded:—

1. Immediately after the removal of the fruit from store from 80 to 90 per cent. of those stored at 32° F. were found to be affected, the extent of affection varied from very slight to very bad. About 10 per cent. were so badly affected that their condition was evident without slicing.

2. Apples examined at the same time, which were stored at 34° F. showed that about 20 per cent. were affected. None of these were as badly affected as those stored at 32° F.

3. Although apples were stored in chambers with different systems of refrigeration, at each of these temperatures, there was no definite difference in the numbers affected in these chambers.

4. Apples were received which were grown in different situations, though from the same district. From one of these orchards two separate consignments were received, one a fortnight before the other.

* Bull. 94, Bur. of Chem., U.S.D.A.

When stored at 32° F., no definite differences in the numbers affected in any of these lots could be ascertained.

5. After removal from store the numbers that became soft increased. This was especially the case with those stored at 32° F.

Rymers, after a long storage period at 32° F., may show a browning of the core region flesh. An illustration of apples so affected is given.

Unfortunately here, even more so than with the Rokewoods, the opportunities for observation were limited. So much so was this the case that even general remarks cannot be offered as to the relative effects of temperature. After removal from the store, while the discoloration apparently increases in its density, no outward evidence of the condition is noticeable.

The similarity in the appearance of this trouble, and that technically described as "Brown Heart" is worthy of notice. Certainly the conditions under which some of these affected fruits were held were such that the concentration of carbon-dioxide that is believed necessary to produce "brown heart" could not be attained.

Further work on this trouble should, therefore, be of fundamental value to the study of "brown heart".

These very scantly observations, it is hoped, may serve as an index of direction for future work, which work, being at the foundation of the fruit storage problem, will necessarily be productive of much good.

Bitter Pit.

This disease was present in only one of the consignments submitted for experimental purposes, viz.:—Dunn's apples, grown at Tongala. The fruit was picked off trees eight years old, which had not previously borne a crop; the fruit, 2¾-inch grade, was put into store on 15th March, and examined 21st November, and except for bitter pit and some wilting, it was quite sound.

Table VIII. gives the results of an examination of these apples.

Table VIII.—Bitter Pit in Dunn's Apples after Eight Months' Storage.

Chamber.	Temperature.	Refrigeration System.	Number Examined.	Pitted	Average
				%	%
1. (*a*) ..	32° F.	Direct expansion and air circulation	78	8	16
(*b*) ..			75	21	
(*c*) ..			75	19	
2. (*a*) ..	32° F.	Direct expansion ..	105	17	17
(*b*) ..			83	18	
(*c*) ..			76	15	
4. (*a*) ..	34° F.	Air circulation	94	28	26
(*b*) ..			69	24	

Consideration of these figures show that the disease is more prevalent at 34° F. than it is at 32° F.; this confirms previous experience as to the effects of temperature on the development of pit. The method of estimation and the nature of the disease necessarily

give rise to some variations in results, the error of which the reader can estimate himself.

Wilting.

This cool storage trouble is one of variable importance. Conditions in the orchard and in the cool store may both or separately affect its incidence. Some varieties are more susceptible to wilt than others. The variety Scarlet Nonpareil, last year, was easily the worst to wilt in the experimental chambers. Dunn's was another susceptible variety. Many varieties like Granny Smith or Sturmer did not show any wilting after an eight months' storage period.

The maturity of an apple is an important factor in controlling wilt in store; particularly so since the orchardist himself has practically absolute control of the time when the fruit is picked. Immature apples wilt worse than fully mature apples. Fully mature apples wilt slightly worse than do medium mature apples. The maturity of an apple for general purposes is estimated from a consideration of the tone of the green ground colour. A medium mature apple is one which shows a light green colour. While the ambiguity of this term is recognised, it is thought to be the most accurate, yet simple, criterion of maturity for the orchardist. The acquisition of the art of selecting such apples can be gained only by experience.

Of cool storage conditions the temperature is of some importance. Apples wilt worse at 34° F. than at 32° F. This, however, may really rather be the result of differences in relative humidity, which it has been seen is lower at 34° F. than at 32° F. Some preliminary experiments on the loss of weight in apples stored at 32° F. for four months were carried out. These showed losses of from 2.2 per cent. with Stone Pippins to 3.5 per cent.—the extreme with Dunn's apples. These experiments, it is hoped, will be developed in extent.

Losses Caused by External Organisms.

The following fungi have been isolated from apples in store:—*Penicillium glaucum* Link, *Penicillium* sp., *Venturia inaequalis* (Cke), Aderh., *Sclerotinia fructigena* (Pers.) Schr., *Gloesporium* sp., *Cladosporium* sp., *Pleospora* sp., and *Botrytis cinerea* Pers. The *penicilliums* are the commonest fungal causes of loss in apple cool storage.

Botrytis cinerea, which affects the calyx or "eye end" of an apple, may, under favourable conditions for its propagation, become serious. Under such conditions, the fungus develops a dense, white, felt-like mass, the mycelium. Apples in the neighbourhood are infected so that nests of rotten apples may be found. The *Penicilliums* and many storage rot fungi require an injury to the apple before they can develop on it. The main cause of such an injury is bruising. This should be remembered as an important factor in affecting mould development in stored apples.

In studying the relative effects of temperature, it was therefore assumed that any one consignment received uniform treatment in the matter of handling unless there was special notice to the contrary.

Table IX. gives the results of such a study with a consignment of Rome Beauty apples.

Table IX.—Rome Beauty Apples from Drouin showing the Relative Development of Moulds at Different Temperatures, and under Different Systems of Refrigeration: One Case Stored in each Chamber for Seven Months.

Chamber No.	Temperature.	Refrigeration System.	Mould.	Average.
			%	%
1	32° F.	Direct expansion and air circulation..	6	
2	32° F.	Direct expansion	12	9
26	32° F.	Air circulation	10	
3	34° F.	Direct expansion	8	
4	34° F.	Air circulation	12	13
5	34° F.	Direct expansion and air circulation..	18	
6	37° F.	Direct expansion and air circulation..	30	
7	37° F.	Direct expansion	18	23
8	37° F.	Air circulation	22	

From this table an increase in mould development with temperature increase can be noted.

An opportunity to study the importance of wrapping fruit in a condition susceptible to mould losses was afforded by the receipt of some fully mature Dunn's apples from Beechworth. Three cases of these apples were received and stored at 32° F. One case had every layer wrapped, another alternate layers, and in the third no fruit was wrapped at all.

Table X gives the results of examining this fruit:—

Table X.—Dunn's Apples from Beechworth Stored for Six and a half Months at 32° F.

Treatment.	Mould.	Sound.	Sound.
			%
Wrapped	0	131	100
Alternate wrapped	7	116	94
Unwrapped	21	93	82

This table demonstrates the value of wrapping fruit for long storage, where, for any reason, the fruit is susceptible to losses from mould decay.

The value of wrapping pears has been mentioned in a previous article. The difference between apples and pears in their resistance to the inroads of moulds seems rather to be one of degree than one of kind. This resistance is closely correlated with their respective capacities to withstand mechanical injuries during handling.

The tender Jonathan apple is as susceptible to mould losses as some of the harder pears, when handled and stored under similar conditions. Some apples when picked at the right time are so hard that the ordinary, even the rough handling which fruit in practice frequently receives, does not materially affect their keeping qualities. With such

varieties, wrapping alternate layers will give satisfactory results. Sturmers, Stone Pippins, Granny Smith, and Rymer are some varieties which may be packed like this.

Finally, it is interesting to notice that the fungus *Venturia inaequalis*, the cause of Black Spot, will grow and produce conidia on the apple surface at 32° F.

NOTES ON THE KEEPING QUALITIES OF SEVERAL VARIETIES.

It should be remembered that these remarks refer in many instances to one consignment from one district, and only to the past season's fruit. Most of the fruit was put into store, either at the end of March, in April, or the beginning of May.

Buncombe.—A well-coloured firm variety, which stores well till August-September. By this latter time, brown scald-like streaks appear; it is this feature that limits its storage life. The flavour after storage is very good, and the flesh is firm and sweet. The loss from mould is small. September 1st is the latest safe date till which this variety should be held.

Cole's Champion.—An attractive looking variety, which, however, does not store well. Flesh collapse is the source of fairly extensive deterioration. The aroma and flavour are both poor. Normally it has not the appearance of a good storage apple. It is necessary to state that these observations were made on one case of fruit, which case was fully mature, picked from young trees. The writer does not think this is nearly as good an apple from the storage stand-point as the Jonathan, which apple it, in some measure, resembles.

Dunn's.—This is a good storage apple. It is very free from skin blemishes resulting from storage. The flavour, sweetness, and firmness of the flesh are each well developed. The advent of mould decay and wilting serve as limiting factors to the storage period. Both these can be regulated to some extent by picking at the correct time, and exercising care in handling. When the apples have acquired a light green colour it is the correct time to pick them. When stored at 32° F., they may be held safely in store for eight months.

Edna May.—This is an excellent storage variety. The apples submitted were grown in Gippsland. It is well coloured, firm, nicely flavoured, and stores in perfect order for seven months. It should be an excellent apple to grow in Gippsland for export purposes.

Granny Smith.—A very sound and excellent keeper. Although the amount of loss caused by mould is small, fruit which has been wrapped is more attractive in appearance after a long period of storage. The fruit is slightly susceptible to scald, which shows up in store about the middle of November. November 1st is the latest safe date that it is advisable to hold this variety.

Jonathan.—This is a medium to good storage apple. While a period of storage has been assigned to the different varieties, it should always be borne in mind that this "life" is dependent on conditions affecting the apple's history previous to storage. This is especially true with the Jonathan. Among the more obvious factors that determine the storage life of the Jonathan apple is its grade. Small grades (2¼ inches) of sound apples were held in good condition till November.

Similar apples of larger grade cannot be successfully held for such long periods. The storage period is governed by the grade. Apples of the 2½-inch grade should not be held longer than six months, the 2¾-inch grade for not longer than four months. These facts indicate the importance of careful grading when packing Jonathans for cool store. The loss, and consequently the storage life of any sample, is determined by the rate of deterioration of the poorest samples. Care in grading has also an economic aspect. Can the man, who has a mixed grade of fruit, where its storage life is determined by the rate of deterioration of the poorest (here the large grade sample) compete with another who has well-graded fruit, and who, therefore, not only has large apples when the former has apples, but also has other smaller apples to sell when his rival has none?

Other conditions, to some extent controllable by the grower, are also important determinants in the cold storage life of apples; maturity and colour may be mentioned here. Though mentioned separately, these two qualities are not entirely independent. Advancing maturity and colour development proceed, to some extent, side by side. The importance of maturity on scald susceptibility, Jonathan spot, and on internal breakdown need not be recapitulated here. Colour, or possibly to express it more correctly, conditions conducive to the development of a good blush, seems, independently of maturity, to have some effect on scald and Jonathan spot development. Pruning to allow the maximum of light to penetrate the trees, and other methods of improving colour production, should be encouraged.

London Pippin.—This apple is a good keeper. If picked when it is a light green colour, it will mellow in store. After long storage the apple is subject to a diffuse surface browning. Apart from this not very serious blemish, the chief cause of deterioration is mould. This variety may safely be stored for seven months. Wrapping alternate layers is sufficient.

Lord Wolseley is a good, firm storage apple. It is peculiar in that the surface of the apples becomes quite sticky. Wrapping alternate layers gives satisfactory results. If picked when full grown, and of light green colour, stores very well till November. This variety, it should be mentioned, is liable to bitter pit, though no apples so affected were found in any samples submitted.

Norfolk Beaupin.—A well-coloured firm apple that keeps well in store for five months. Last season, after this time, it rapidly deteriorated owing to the development of scald. The taste after storage is poor. This apple cannot be recommended for storing.

Rokewood.—A very firm and well-coloured apple. Internal breakdown is the determinant of the storage life of this variety. There is practically no other cause of deterioration. Safe storage seems to be limited to six months. 34° F. is a more satisfactory storage temperature for this variety than is 32° F.

Rome Beauty.—This apple shows remarkable variation in keeping qualities. These variations are dependent on its life history previous to storage. Some Rome Beauty apples of excellent colour and firmness grown at Beechworth kept with practically no deterioration till the end of November. Other Rome Beauty apples from Drouin, stored at practically the same time, while firm, were poor in colour, and reached

the end of their "storage life" about July. Another lot of Rome Beauty apples was received from Geelong. These apples were firm, and the colour was medium, well developed; they stored well till the end of October. Some of these apples were grown on grass land, *i.e.*, uncultivated land, apples grown on such land colour better than do those grown on cultivated land.

Rymer.—A fair to medium quality of storage apple. The apple is fair to well coloured, firm, but essentially a culinary apple. The variety is susceptible to scald and internal breakdown, particularly in the core region. With more mature apples the incidence of mould becomes an increasingly important factor in determining losses. August to September is as late as it is advisable to hold this variety. When picking, the grower should not be deceived by the amount of blush, since in some districts a good colour may develop before the fruit is really mature enough to give the best results from storage. The tone of the ground colour of green should be taken as a guide. Wrapping alternate layers gives satisfactory results. A storage temperature of 34° F. is better than 32° F. for this variety.

Scarlet Nonpareil.—This is not a good apple to store on account of its liability to wilt and to Jonathan spot. There is also some loss caused by moulds, but it is free from scald. July is as late as this variety should be stored. If it is stored, wrapping alternate layers is sufficient.

Statesman.—A good storage variety. Firmness and flavour are both well developed on its removal from store. The variety is free from storage skin blemishes. It is limited in storage life by the development of moulds; shows a very slight tendency to wilting. This variety may safely be stored till November. Wrapping alternate layers is sufficient for local storage purposes.

Stone Pippin.—A firm variety which can be stored with safety till September. About November a characteristic form of scald develops on these apples in cool store. This feature limits their "life." Attention should be given to picking at correct maturity, and, if necessary, to other factors influencing scald incidence. Wrapping alternate layers gives satisfactory results.

Sturmer.—A good storage variety; sweetness, and taste are well developed in store. Free from skin blemishes and losses caused by fungi. Shows slight tendency to wilt, particularly if the apples are a little too green when picked. It is safe to store this variety until December.

Winter Majetin.—Only a fair storage variety; it is liable to scald, the onset of which limits its safe "life" in store to July or August. Taste and quality are fair. The loss caused by mould is small. If this variety is stored, special precautions should be taken to prevent scald. Wrapping alternate layers is advisable. It should be stored in a position to get maximum ventilation.

Yappeen.—An attractive looking and excellent keeping variety. Free from skin blemishes, showing no loss after seven months' storage. The taste, however, under all conditions of storage leaves much to be desired.

Yates.—An excellent keeping variety. The firmness, sweetness, and flavour are each well retained and developed. This apple is without

doubt the best dessert variety that we grow for long storage purposes. Can be held with practically no deterioration till Christmas time.

GENERAL SUMMARY.

1. Apples to be stored successfully for long periods must fulfil certain conditions in their "pre-storage" life. They must be the correct variety, grown on trees under good conditions, and of suitable age, picked at the right stage of maturity, packed and transported with the necessary degree of care. A modification of any of these conditions affects to varying degrees what might be termed the ideal "storage life" of an apple. Some, though admittedly slight reference has been made to each of these conditions.

2. Of these conditions, possibly the one of picking at the correct maturity is the most important, since it can be controlled almost entirely by the grower himself. Its relation to scald, Jonathan spot, flesh collapse, and to mould development have each been considered.

3. Conditions in the cool store are also important for successful storage. The main conditions are (*a*) temperature; (*b*) system of refrigeration. Of these the more important is temperature. For general storage purposes a temperature of 34° F. is recommended rather than 32° F.; particularly is this the case where large quantities of apples susceptible to internal breakdown are stored. Little, if any, effects on the keeping quality which could be ascribed to the different systems of refrigeration used, was noted.

4. An analysis of the various causes of deterioration of apples in store, and their relation to the varied conditions outlined above has been attempted.

5. Scald seems to be due to undue concentrations of fruit esters about the fruit. Remedies require that this should be removed. To do so, the fruit should be well ventilated or wrapped in ester absorbing oiled wrappers.

6. Jonathan spot development is dependent on (*a*) the variety; (*b*) the maturity at picking time. Scarlet Nonpareils and Jonathans were both badly affected. No cause can be definitely assigned for this trouble.

7. Internal breakdown appears to result from the reaction of a particular inherent constitution, and low temperatures over a certain period.

8. The relative development of bitter pit at two temperatures was found to be proportional to those temperatures. After a six months' storage period greater numbers were found to be affected at 34° F. than at 32° F.

9. Some fungi found growing on apples in cool store at different temperatures have been enumerated. The relative effects of different temperatures, and of modes of packing on mould development have been considered.

10. Wrapping alternate layers gives quite satisfactory results. So far, only variation in mould development can be correlated with this practice; however, in large chambers the better facilities for ventilation may be advantageous.

The wrapping of alternate layers of firm varieties from the keeping stand-point is frequently all that is required.

11. Some remarks have been added on the keeping qualities of the different varieties. An attempt has been made to delineate in each instance the cause of deterioration after a period of storage. The method of studying and eliminating these limiting factors, as far as is possible, is surely a sound way to improve and extend the period over which fruit can be successfully stored.

. . . . . .

The writer is pleased to take the opportunity here of thanking the orchard supervisors and growers concerned in collecting the fruit and necessary information regarding conditions in the field.

This work, from the very nature of the subject under consideration, can at best only be regarded as a preliminary study, and, should it serve as an indication of the most profitable lines for future investigation on this subject in Victoria, something has been accomplished.

SILO BUILDING AND THE MAKING OF SILAGE.

The following notes on the making of silage and the building of a silo by Mr. John Kerr, of "Olinda Yarra," Yering, are reprinted from *Stock and Land*:—

"I gladly give my experience of ensiling fodder practised here. I might say that on this farm, where 160 cows are being fed and milked, the silo is given precedence over every other system of fodder-conservation, and has been so preferred for over thirty-five years. It is still first favorite as a means of providing the bulk portion of the fodder-continuance necessary to payable dairying operations.

Like your other correspondents, I have wondered why many dairymen, otherwise displaying serious intent to treat their cows properly, have continued so long to overlook it. I know that, should the herd here by any circumstance be deprived of the regular ensilage ingredient in the ration supplied, there would be a considerable diminution in the annual returns. The cows here look to it from the time they can chew, and never during the time since I first adopted the process have they wanted for it, when they needed it most.

For about the first twenty years of my using ensilage, underground pits were employed, and answered every purpose except the convenience of emptying. The overground silo was then adopted, and the two silos (one of brick and the other of concrete) then built have been in bi-annual requisition without a break ever since. Each is of about 120 tons capacity, and a full 480 tons of maize and Algerian oats goes through them every year, at a usual cost of about 10s. a ton for the maize and 15s. for the oats. This cost includes interest on the £200 spent on their original construction.

The practice followed here is to fill with the oat crop about December of each year, to be used immediately, calves, as well as the milch cows, receiving a share. By the end of April the silos are again empty and available for the maize crop.

All crops are chaffed for their better packing, and convenience also of both elevating and extracting. Close packing is necessary to exclusion of air, which latter is all essential. Indeed, I find that the whole secret of good ensilage is summed up in effective expulsion and exclusion of air from the material. What contributes to this contributes to the quality of the output.

To this end—exclusion of air—certain structural features and certain filling practices must be observed. Here are some of these essentials, all, necessarily, within the bounds of economy—

(1) Air-tight non-absorbent walls (brick, concrete, wood or iron).
(2) True cylindrical shape and smooth internal wall surface. (A corner, a bump, a roughness on a contracting diameter impedes settling; concavities in the wall face admit air.)
(3) A depth or height not less than 20 feet. (The main proportion of the silage is thus preserved by the greater pressure from the material itself, leaving only the uppermost few feet to receive special attention.)
(4) A diameter in proportion to the number of animals to be fed. (Once opened, 3 inches of the whole surface must be used daily, or mould will begin to appear, with consequent spoiling.)
(5) The chaffing of the material being ensiled. (To cause closer packing and to obviate the heavy labour of tearing unchaffed contents asunder when extricating.)
(6) The effective mixing of the heavier and lighter material, which invariably become segregated in their descent. (If flag or leaf is allowed to accumulate in one quarter near the wall, admission of air and consequent mould invariably occurs. Preferably this light material should be kept toward the centre.)
(7) Filling fast enough to protect from air-exposure as soon as possible. (Air not only favours decomposing mould growth, but also causes excessive oxidation—combustion—which will go on to the point of charring at least, if not corrected by continuance of filling.)
(8) Suitability of crop. (Some crops are too "squashy," such as rape.)
(9) The right stage of ripeness. (If cut too green, even such suitable crops as maize and oats come out too sour, and perhaps "squashy" also, unless toned down with dry oaten or other chaff. If cut too ripe, the lightness makes exclusion of air impossible, and a dark, charred product results.)

Personally, from my own acquired knowledge, I can confidently recommend the following to any one desirous of the better feeding of their stock, viz.:—

A silo of machine-made bricks, laid in cement; 9-inch walls for half the height and then 4-inch for the remainder, with a reinforced flange on top 9 inches wide (on which to rest weighing material, to be referred to later). The first 14 feet to be reinforced, during building, with two encircling black No. 8 wires on every row of bricks, and the 4-inch brickwork with one similar wire on every row. Make the silo

not more than 2 feet underground and 28 feet above (30 feet deep in all). Diameter to be according to number of cows (not more than 10 feet for 20 cows and 20 feet for any number over 80). Diameter not to vary a fraction of an inch at any spot. Finish off internally with 2 to 1 cement plaster and a straight edge carefully applied from top to bottom. Introduce the only port hole (2 ft. 6 in. x 1 ft. 6 in.) at ground level, to be used with an internal shoot of movable transverse boards from top to bottom.

Ensile Algerian oats, or cereals and legumes (mixed) at the milky stage of the grain. Maize, however, is the best ensiling crop of all. Cut when the grain has attained full size and begins to dent. Thoroughly mix and distribute the stuff oneself all the time the cutter is working, not trusting it to the hired man out of sight under conditions which make sitting down more comfortable. All through the filling keep the portion of the surface that is against the wall as high as practicable in advance of the centre. For the bottom third of the silo even 2 feet a day is a safe and proper rate of filling. The rate should then be gradually increased, until, near the top, as much as 10 feet a day may be put in, with advantage. At this stage settling occurs much faster, and all hands must keep hard at it to save what would otherwise spoil.

Trampling, especially around the wall, now becomes advisable, to save the top, which, unlike the lower, lacks overburden to protect it from air admission.

To fill a silo completely the material must be carried several feet above the walls to allow for settling. The best method of containing this for the short time until it subsides is to stack 3 feet of loose bricks around the top of the wall as reasonably smooth and plumb inside as possible. (If carefully laid they will hold up to 3 feet quite securely.) When settling becomes so slow as to make further filling not worth while, weighting and sealing may be undertaken. And here the bricks again serve.

For sealing use plain galvanized or black iron sheets that have been tarred. Cut enough outer ones so that they fit closely the concavity of the circular internal wall right around. (The remainder do not need cutting.) Give each sheet an overlap of at least 6 inches over its fellow, and lay them all as flat as possible over the whole area of the surface. If the ensilage is to stand long before use, several inches of air-excluding material, such as soil, should be added, and then the bricks; but if not to stand long, an inch or two of soil and the bricks will serve. If feeding is to start very soon, soil is not worth while. Then use just the iron sheets and the bricks, always laying the latter close together. When about to open the silos, the bricks should be again stacked carefully, in readiness for the next filling.

In conclusion, I would stress the principle of the ensiling process, viz., air exclusion."

The Report on the Egg-laying Competition which ended on 31st March last will be printed in the July *Journal*.

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Actual Photograph of Bokhara Clover grown at Portland on heath lands, without manure, and without irrigation (Seed supplied by us)

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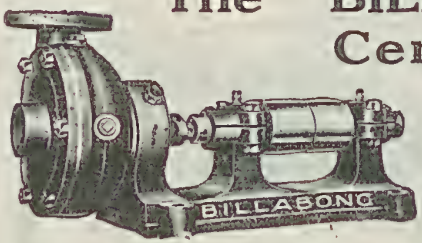

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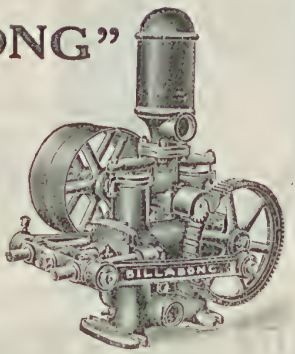

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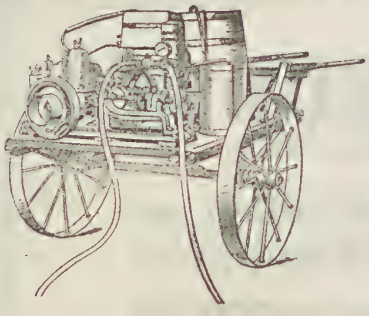

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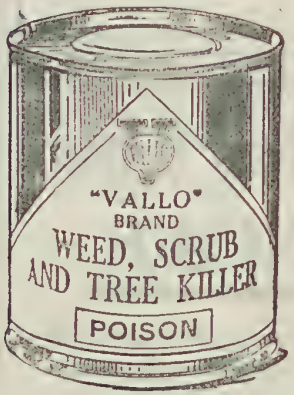

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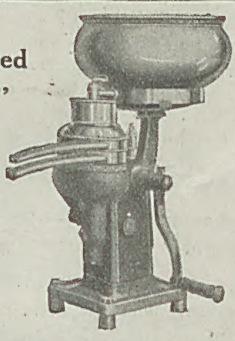

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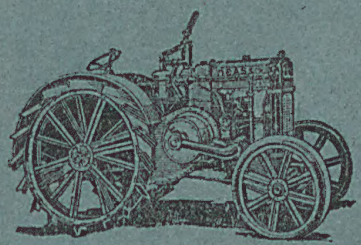

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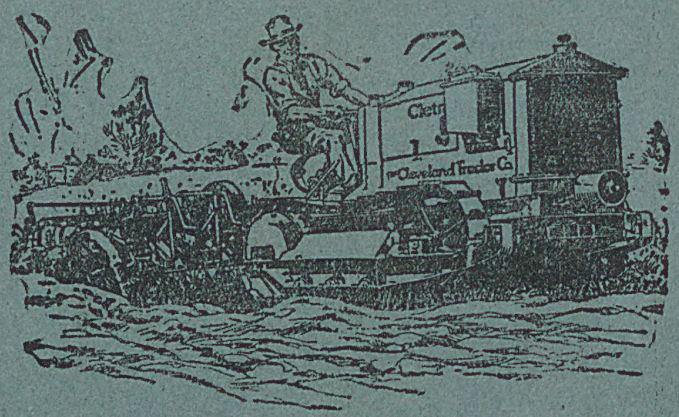

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